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# ECONOMIC EVALUATION

OF

# FEDERAL WATER RESOURCE DEVELOPMENT PROJECTS

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## REPORT

TO THE

## COMMITTEE ON PUBLIC WORKS

HOUSE OF REPRESENTATIVES

BY MR. JONES OF ALABAMA

FROM THE

## SUBCOMMITTEE TO STUDY CIVIL WORKS

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# ECONOMIC EVALUATION OF FEDERAL WATER RESOURCE DEVELOPMENT PROJECTS

## STANDARDS OF ECONOMIC EVALUATION

In the consideration of a proposed project for the development of water resources one element of high importance is the economic evaluation. Usually costs and benefits are reduced to dollar equivalents and expressed as a ratio of benefits to costs. If this figure is in excess of unity it is generally considered that the project is economically justified.

Notwithstanding the importance of this element, it appears that the pertinent law is not particularly specific and that the practices of the agencies are far from uniform. Under present procedures one agency might find a favorable benefit-cost ratio while a second examining the same proposal would come to an adverse finding. Such a situation leads to the bargaining on the part of local interests with the Federal agencies and leaves Congress not only in a poor position to compare one project with the second but more importantly in a poor position to understand the true economic merits of a single project.

There appear to be only two provisions in law that bear directly upon the subject. One of these appearing in section 1 of the Flood Control Act approved June 22, 1936, reads as follows:

> * * * that the Federal Government should improve or participate in the improvement of navigable waters or their tributaries, including watersheds thereof, for flood-control purposes if the benefits to whomsoever they may accrue are in excess of the estimated costs, and if the lives and social security of people are otherwise adversely affected.

The second provision appears in section 9 (a) of the Reclamation Project Act approved August 4, 1939, which reads as follows:

> If the proposed construction is found by the Secretary to have engineering feasibility and if the repayable and returnable allocations to irrigation, power, and municipal water supply or other miscellaneous purposes found by the Secretary to be proper, together with any allocation to flood control or navigation made under subsection (b) of this section, equal the total estimated cost of construction as determined by the Secretary, the new project, new division of a project, or supplemental works on a project, covered by his findings, shall be deemed authorized and may be undertaken by the Secretary.

Both of these pieces of legislation are quite general and leave completely to the discretion of the administrative agencies the determination of what constitutes a benefit, how its monetary value should be determined, what amortization period should be used for structures, and what interest rates should be considered applicable in financing.

A subcommittee of the Federal Interagency River Basin Committee, a voluntary organization of six of the departments, has been engaged for over 5 years in an exhaustive study of the economic analysis of

water-resource projects and is reported to be now approaching completion of its studies which have been undertaken with a view toward formulating mutually acceptable principles and procedures for determining benefits and costs. A report of that subcommittee entitled "Proposed Practices for Economic Analysis of River Basin Projects" published in May 1950 summarizes the practices of the different agencies current at that time. Assuming that the Federal Interagency River Basin Committee should arrive at proposed uniform standards of evaluation, there is no requirement that any agency adhere to the findings of this voluntary group. It is reported at the present time that the committee is experiencing considerable difficulty in resolving differences among the agencies as to the evaluation of secondary or indirect and intangible benefits.

## VIEWS OF WITNESSES

During the course of the hearings conducted by the subcommittee, the subject of economic evaluation was discussed with several witnesses.

At one point in the discussion of the existing situation reported by the Chief of Engineers that a number of projects now authorized never would be built, Chairman Jones stated to General Pick:

> So we would like to have you comment now on what method we could use to eliminate a recurrence of authorizing projects that never get anywhere.

To this General Pick replied:

> I think that that will be reflected in the economic justification of the project. I think and I hope that during these hearings the committee will review carefully the procedure in working out the economic justification of projects. I think that the committee should insist that a sound method—if the one that is being employed now is not considered sound—that a sound method be arrived at for determining the economic justification for projects. Then I think the committee should set a deadline on projects presented to it by the Corps of Engineers and to insist that it has the minimum economic justification, to say the least, and the committee's actions be based in some important measure on whether or not the project is economically justified in the beginning.

The phraseology of this answer might indicate that the Chief of Engineers considered that the present method of determining the economic justification of projects was not sound. Later in his testimony he touched on the subject as follows:

> On the question of submitting favorable or unfavorable reports, if the Corps of Engineers adopted a policy of exerting more rigid requirements to determine economic benefits you could expect a reduction in the number of favorable reports. The Corps of Engineers' criteria for determining the economic benefits now, I think, are more rigid than those generally applied by other agencies which render reports and receive authorizations for the work involved from the Congress. If the project does not have a favorable economic ratio, the minimum of unity, then we cannot make a favorable report. If you were to raise that requirement 1½ to 1, let us say, you could cut down the number of favorable reports.

At a later point in his testimony the Chief of Engineers specifically recommended that Congress—

> Set a definite policy for the figuring of economic benefits and make that uniform for all Government services involved in this kind of a program.

Commissioner Straus of the Bureau of Reclamation stated that economic analysis of reclamation projects consisted of two parts. He said:

> The first, required by reclamation law, consists of an allocation of project costs among the purposes served and a showing that the anticipated project revenues will return all reimbursable costs. The second, although not required by reclamation law, is the showing of estimated benefits and costs, and is made as a matter of Bureau policy. Thus, a reclamation project must meet two standards of economic feasibility: The estimated benefits must exceed the estimated costs and the anticipated project revenues must provide for return of all reimbursable costs.

The Commissioner furnished the subcommittee with a copy of the regulations of his Bureau pertaining to economic analysis and made

no comment as to the soundness of the methods used by his or any other agency.

Chairman Buchanan, of the Federal Power Commission, offered the following comment on the subject:

Although the Commission directs its attention principally to the water-power aspects of Federal multiple-purpose reservoir projects and river-basin programs, it has considerable familiarity with the procedures now in use by the several Federal agencies for making economic analyses of such proposals, and it is the Commission's considered judgment, after much study and experience, that there is need for the adoption of a uniform method of project evaluation which would result in a standard form investment appraisal statement for each project.

The investment appraisal statement should include a complete but concise estimate of project cost—both capital cost and average annual cost—together with an estimate of the value of the average annual benefits expected to be derived from the project. Anticipated intangible benefits should be weighed but cannot be measured precisely in terms of dollars.

It is recognized that practically every reservoir project will result in certain adverse effects of a temporary character on the local economy, but incidental beneficial effects attributable to the project and of which no account is taken will outweigh such adverse effects almost without exception. Inasmuch as it is not customary to evaluate incidental benefits in terms of dollars, no attempt should be made to reckon adverse effects in that manner. In other words, reliance should be placed upon the more direct or primary types of benefits and costs susceptible of being evaluated.

If the average annual benefits obtainable from a reservoir project exceed the estimated annual costs, the project should be classified as eligible for immediate authorization; otherwise it should be held over for possible future consideration.

The Engineers Joint Council in its report, Practices of a Sound National Water Policy, released in July 1951, indicated considerable concern with Federal practices in the evaluation of benefits. Dr. R. D. Hoak as spokesman for the council introduced a statement on the subject appearing on pages 537 to 540 of the hearings. The following is extracted from his testimony:

The Federal Government should not undertake any water development which is not economically justifiable in the sense of being financially justifiable. For determining such justification, there should be established criteria which are applicable to all functions of such development and to all Federal agencies concerned.

In the appraisal of a water-resources development and its component functions, the benefits should be expressed in average annual monetary terms.

The benefits to be considered should be net benefits.

In determining benefits and detrimental results, there should in general be taken into account only those benefits or detriments which will accrue to contemporaries of the project.

Tangible benefits should be determined in net, not gross amounts.

Intangible benefits or detriments should not be considered in determining economic justification.

In order that Federal water-resources developments may qualify as being economically justified, the ratio of tangible benefits to cost, each on an annual basis, should not be less than 4 to 3.

It should be borne in mind that unless there is net gain, in benefits as compared with cost, the result of a given water-resources development will not be an increase in the national wealth. This consideration in itself calls for a substantial margin.

As the specific method of making actual or hypothetical payments in liquidation of the investment in Federal water developments and in computing their costs, whether or not to be reimbursable to the Treasury, amortization should be on the straight-line basis and involve a period of not more than 50 years.

The charge made for the use of money should cover all aspects of all such cost.

## CURRENT PROCEDURES

The subcommittee has examined material presented by the agencies setting forth the procedures currently in use. The following paragraphs constitute a comparative résumé of these procedures. Its presentation in this report is made solely for illustrative purposes and its presentation is not to be considered as an endorsement in any part.

### Benefits and Costs

The standard economic evaluation of a project consists of a comparison of the benefits and the costs as determined by the agency concerned. Benefits are the value of the goods and services created or saved by the project. The costs are the value of the goods and services used in establishing the project and in realizing the benefits. Benefits and costs are divided into two categories: (1) the tangible benefits and costs, those which are measured in monetary terms, and (2) intangible benefits and costs, those which are not measured in monetary terms.

#### TANGIBLE BENEFITS AND COSTS

Tangible benefits and costs are of two types, direct or primary and indirect or secondary. Direct or primary are those which result directly or immediately from the project. These include the value of crops produced on an irrigation project, damage (potential) averted by a flood-control project, the value of energy from a hydroelectric project, and savings in transportation costs resulting from a navigation project. Direct costs are of two types, project costs and associated costs. Project costs include both Federal and non-Federal involved in the actual construction of the project. Associated costs include those additional costs incurred in making the products of a project available for use or sale. The latter type are principally those incurred by private individuals and include such items as a farmer's investment and operating costs, shipper's operating costs, and the like.

Indirect benefits are the additional values that result from activities stemming from or induced by a project. Examples of such indirect or secondary benefits are the values added by transporting, processing, and distributing the products of an irrigation project; the increased income of local businesses that serve the project; and the increase in incomes of persons using power from a project. Indirect costs are the values of the additional goods and services used in producing the indirect benefits, such as the investment and operating costs of a businessman.

In order to compare the tangible benefits and the tangible costs, the two are associated in a benefit-cost ratio. For the purposes of analysis, all the benefits and all the costs are converted to an annual average basis. Because the project is evaluated from the Federal point of view, all the benefits, less the associated and indirect costs, are set against the project costs in the ratio.

### INTANGIBLE BENEFITS AND COSTS

Intangible benefits and costs are the effects of a project that are not measured in monetary terms. Examples of intangible benefits are the provision of an adequate resource base for an expanding economy or the saving of human life by controlling floods. Intangible costs are the values consumed that are not measured; an example would be the destruction of scenery by a reservoir.

## Project Costs

Project costs are the costs necessary to establish, maintain, and operate a project. There are two steps used in computing the project costs: estimating investment cost and estimating average annual cost.

### INVESTMENT COSTS

The investment cost includes the costs of land acquisition, post-authorization planning, structures, equipment, land development, damage to installed facilities, and similar items.

If the period of construction and development is at least 1 year, some agencies also include, as an investment cost, interest on the investment during construction. The interest charged to the project is the product of the interest rate times the amount of the investment times one-half the construction period. Only one-half the construction period is used because the agencies assume that the money to be spent will be spread fairly equally over the entire construction period. For the interest rate, the Corps of Engineers uses 2½ percent for Federal funds and 4 percent for non-Federal funds.[1] The Bureau of Reclamation and the Federal Power Commission also use a rate of 2½ percent, which is the weighted average interest on long-term Government loans. Since the Department of Agriculture assumes that benefits accrue during the period of construction, it does not include interest during construction as an investment cost.

The total of all investment costs, including interest during construction when charged, is the gross investment cost.

The net investment costs equal the gross investment costs less any allowances for the salvage value of land, structure, power facilities, and other equipment. The Bureau of Reclamation estimates the value of the item at the end of the period of analysis and discounts that value to a present worth. With the exception of land, the value at the end of the period of analysis is based on straight-line depreciation.

For example, an element of a project may have an estimated life of 100 years and cost $80,000, while the project as a whole has an estimated life of 75 years. Since the life of the element exceeds the life of the project by 25 years, one-fourth of the element's life, its value at the end of the life of the project will be $20,000, one-fourth of its original value. The present worth of this future value is an amount which, if invested at 2½ percent compound interest, will equal $20,000 at the end of 75 years. In this case, the present value would be $2,800.

In estimating the salvage value of land, the Bureau does not decrease the value by depreciation; otherwise, the method is the same.

[1] Before June 6, 1952, the corps used 3 percent for Federal funds and 3½ percent for non-Federal funds.

The Corps of Engineers usually does not make allowances for the salvage value of either structures or equipment. In the case of structures, it assumes that they will not have any value at the end of the useful life of the project. In the case of equipment, it assumes that the cost of salvage will equal the expected salvage value. In the case of land, however, the corps uses the same general method as the Bureau. Neither the Department of Agriculture, which assumes that its projects have a perpetual life, nor the Federal Power Commission make allowances for salvage value.

### ANNUAL COSTS

The annual cost of the project is the sum of the interest on the investment, the annual amortization charge, the interim replacement costs, the operation and maintenance costs, and the incidental charges.

All of the agencies charge interest on the project investment. They differ, to some degree, on the definition of the principal and on the amount and type of interest. The Corps of Engineers, the Federal Power Commission, and the Department of Agriculture all define the principal as the gross investment. The Bureau of Reclamation uses, as the principal, the net investment, which is the gross investment less the allowance for salvage. In actuality, there is no difference between the Bureau and the other agencies. As already pointed out, the Bureau charges interest on the allowance made for salvage; the interest rate is the same for the salvage allowance as it is for the net investment. The amount and the type of interest that is charged varies from agency to agency. The corps uses a rate of 2½ percent simple interest for Federal and non-Federal public funds, and 4 percent for private funds. The Department of Agriculture uses 2 percent simple interest. The Federal Power Commission uses 2½ percent simple interest. The Bureau of Reclamation uses 2½ percent compound interest. The 2½ percent rate used by the Bureau, the corps, and the Federal Power Commission is the weighted average of interest on long-term Federal securities.

The purpose of amortization is to have a fund equal to the original investment at the end of a certain period, usually the life of the project. Since the Department of Agriculture assumes that its projects have perpetual life, it does not use amortization. The Federal Power Commission, the Corps of Engineers, and the Bureau of Reclamation compute amortization, using the sinking fund method. Each year, an amount is deposited in the sinking fund which, plus the compound interest charged on it, will equal the investment. The Federal Power Commission differs in its use of the sinking fund method from the other two agencies. It amortizes the gross investment while the other two amortize the net investment, thus allowing for salvage value. The Commission sets the period during which the investment is to be amortized at 50 years; the Bureau and the corps use the estimated life of the project as the period of amortization. However, the corps has set 50 years as the maximum period that may be used; the Bureau has set 100 years as the maximum period. All three agencies use 2½ percent compound interest.

Interim replacement costs are the costs necessary to replace equipment or structures that have an estimated life shorter than that of the project. Both the Bureau of Reclamation and the Corps of Engineers

have generally similar methods of computing the annual replacement costs. The replacement of a minor element is counted as an operation and maintenance cost. For a major element, the future cost of replacement is estimated and counted back to a present worth. The method of discounting is the same used in discounting salvage values to a present worth. The Corps of Engineers charges interest and amortization on the present worth over the full period of analysis. The Bureau of Reclamation uses a sinking fund. The results of both methods are the same. The Federal Power Commission estimates that the average annual replacement costs will be about 0.60 percent of the total initial investment. This amount is placed in a 2½ percent sinking fund. The Department of Agriculture includes all replacement costs as part of the maintenance cost. The amount is computed by dividing the cost by the estimated life of the item, no allowance being made for interest.

The operation and maintenance costs are those costs, other than the investment and interim replacement costs, which are necessary to operate and maintain the project for its intended purpose. The Bureau of Reclamation, the Corps of Engineers, and the Federal Power Commission include just the costs connected with the project facilities. The Department of Agriculture included the same items plus any increases in operating costs incurred by the farmer. The replacement cost of an element, as pointed out previously, may also be included as an operation and maintenance cost.

Incidental charges are costs that would be incurred by a private project but are not incurred by a Government project. Usually, the purpose is to put private and Federal projects on an equal basis for purposes of analysis. The construction of a Federal project may result in an unfavorable change in local, non-Federal tax revenues and expenditures. The Bureau of Reclamation and the Department of Agriculture assume that any decrease in revenues will be matched by a corresponding decrease in expenditures; and any increase in expenditures, by an increase in revenues. Therefore, neither makes allowances for changes in local tax revenues and expenditures. The Corps of Engineers does make allowances for net loss in revenue. Since improvements that are damaged or destroyed by the project will, in most cases, be replaced, the corps limits the net loss in taxes to an amount equal to the taxes on unimproved land of an area equivalent to that occupied by the project. In computing tax losses, the Federal Power Commission uses a figure equal to the amount of non-Federal taxes that would be paid by a privately owned project. This figure averages about 1.40 percent of the gross investment. The Federal Power Commission is the only agency that includes, in the costs of the project, an average annual charge for insurance, currently the charge is 0.12 percent of the total investment annually. It is also the only agency to include charges for management. This is calculated as equal to 25 percent of the annual operation and maintenance costs.

The second progress report of the subcommittee on benefits and costs to the Federal Interagency River Basin Committee included in the May 1950 published report Proposed Practices for Economic Analysis of River Basin Projects presents a tabular comparison which well illustrates the effect in a computation of annual charges of the different procedures used by the different agencies. The table is reproduced here as table No. 1. This indicates that the same project

analyzed by the Corps of Engineers, the Department of Agriculture and the Department of the Interior could have benefit-cost ratios, considering capital costs only, of considerable difference. If the Corps of Engineers found a ratio of 1 to 1, the corresponding Agriculture Department ratio would be 1.38 to 1, and the Department of the Interior ratio 1.33 to 1. On the other hand if the Department of the Interior ratio was 1 to 1, the Corps of Engineers ratio would be 0.75 and the Department of Agriculture ratio 1.04. The incomparability of benefit-cost ratios reported by the three agencies is obvious.

TABLE 1.—*Annual charges for a given hypothetical project condition*

[Amounts may be read either as percentages or as dollars with relation to an initial Federal investment of 100]

| Item | Corps of Engineers | Department of Agriculture | Department of the Interior | Federal Power Commission |
|---|---|---|---|---|
| Investment in land | 30 | 30 | 30 | 30 |
| Investment in project works | 70 | 70 | 70 | 70 |
| Total initial investment [1] | 100 | 100 | 100 | 100 |
| Period of analysis in years (maximum for each agency is used) | 50 | (2) | 100 | 50 |
| Annual charges other than operation and maintenance: [3] | | | | |
| Interest | 3.00 | 2.00 | 2.50 | 2.50 |
| Sinking fund charge | .89 | 0 | .23 | 1.03 |
| Major replacements | .48 | 1.01 | .52 | .60 |
| Miscellaneous | Small | None | None | 1.52 |
| Gross annual charges (excluding operation and maintenance) [3] | 4.37 | 3.01 | 3.25 | 5.65 |
| Deductions to allow for remaining use value: | | | | |
| (a) Land | .22 | 0 | .07 | 0 |
| (b) Project works | 0 | 0 | .05 | 0 |
| Net annual charges (excluding operation and maintenance) [3] | 4.15 | 3.01 | 3.13 | 5.65 |

[1] Differences in items which would be included in the initial investment by the several agencies and differences in allowances for interest during construction are assumed to be minor and have been neglected.
[2] Perpetuity.
[3] Operation and maintenance charges vary widely for the various types of projects under the jurisdiction of the several agencies and have, therefore, not been included.
[4] Maximum allowance of 50 years beyond period of analysis assumed.

## DIRECT TANGIBLE BENEFITS AND ASSOCIATED COSTS

### IRRIGATION PROJECTS

The Bureau of Reclamation has primary responsibility for developing Federal irrigation projects. The Corps of Engineers also evaluates irrigation benefits and costs in connection with some of its projects. In measuring the direct benefits and costs, it either obtains estimates from the Bureau of Reclamation or else uses the same methods that the Bureau does.

The Bureau of Reclamation defines the direct benefits of irrigation as the value of the increase in agricultural production or of the decrease in agricultural operating costs resulting from the project. Agricultural production covers crops, livestock, or livestock products which are either marketed or consumed by the farm family. Any decrease in farm operating costs is generally a result of an additional supply of water being furnished either to dry farmers or to an already operating irrigation district. Associated irrigation costs consist mainly of the water user's costs of investment, operation, and maintenance. His

major investment costs are for clearing, leveling, ditching, and fencing his land, and his costs for buildings, wells, equipment, and rehabilitation of old plant. The annual interest on the farmer's investment is calculated at 4 percent. The amortization rate is 4 percent compound interest. His operation and maintenance costs include soil preparation, seeding, irrigating, cultivating, harvesting, marketing, equipment and building repair, and farm labor. The method of measurement depends upon the type of project. If it is a new project, all costs are included; if a supplemental water supply project only the net increase in costs is counted. In calculating the expected changes in farm income and costs, the Bureau first estimates the types and sizes of farms with the project and without the project. Representative farms then are analyzed in order to determine what the changes would be for their group.

### WATERSHED MANAGEMENT

The Department of Agriculture carries on watershed management programs through the Soil Conservation Service and the Forest Service. The Department separates the effects of a program into on-site benefits and costs, resulting mainly from increased land productivity, and off-site benefits and costs, such as flood control, water conservation, and sedimentation reduction. This section is concerned only with the on-site benefits and costs; off-site benefits and costs are discussed under the appropriate headings, such as flood control. On-site effects are divided by land ownership into public and nonpublic effects. The public benefits are the increase in income from Government-owned land or the decreased costs of maintenance on roads and highways as a result of the control of erosion and of runoff rates. The costs necessary to realize these benefits are project costs. Nonpublic benefits are a result of runoff and waterflow retardation and of soil-erosion prevention on privately owned land. Decreases in operating costs or increases in productivity are counted as benefits; increases in operating costs or decreases in productivity as associated costs. The calculation of the benefits of a watershed program is done by selecting sample farms or sample areas and estimating the changes in income or costs that would result from the adoption of a program. The results from the sample are then generalized for the region to be covered by the watershed program.

### FLOOD CONTROL

The direct benefits of a flood-control program stem from the reduction of physical damages caused by direct action of floodwaters and from the increased utilization of land formerly inadequately protected against floods. The Corps of Engineers has primary responsibility for flood control. The other agencies, however, deal with flood-control benefits: The Bureau of Reclamation and the TVA as part of their multiple-purpose projects, the Department of Agriculture as part of its watershed programs, and the Federal Power Commission as part of its analysis of projects involving hydroelectric power. All of these agencies obtain estimates for flood-control benefits either from the Corps of Engineers or else by using similar methods.

In estimating damages caused by the direct action of floodwaters, the corps measures all damages, except those to agricultural crops,

on the basis of the cost to the owner for repair, rehabilitation, or replacement. In the case of crop losses, the method used depends upon whether or not replanting is possible. If it is not possible, the loss is the market value of the expected crop less the unincurred costs, such as those of further cultivating, harvesting, and marketing. If it is possible to replant the crop, the flood damage is the sum of (1) the difference in market value of the original crop and the replanted crop; and (2) the increase in farm operating costs as a result of replanting. The figures for average annual flood damages are obtained by studying the frequency and size of the floods on record. The corps estimates the amount of damage that would be done by each height of flood crest if that particular flood should reoccur. The damage at each height is multiplied by the number of floods at that height that have occurred, yielding the frequency-height damages. The sum of the frequency-height damages for the various crests is divided by the number of years in the record; the result is the average annual damage. In some cases, especially when the record is relatively short, the corps will also add the damage that would be done by a design flood, that is a flood that would be just below the top of the levee or capacity of the dam.

The second group of flood-control benefits are those resulting from increased or higher utilization of land resulting from flood control. Included is land protected directly from floods and land, not usually subject to flooding, that benefits from flood control. The annual benefits are measured by applying the local, current, average rate of return (usually 4 or 5 percent) on long-term private investments to the estimated increase in land value. The corps uses this method instead of estimating the earning power directly because it believes that the amount of work involved in the latter method makes it impracticable. In some instances, the other agencies are able to measure the increase in annual revenue directly. If the change in use requires no additional capital investment, the rate is applied to the total increase in value. This method would be used if the increase was the planting of a more profitable crop or the increase in value of a house and lot. When additional capital investments are required, such as the clearing of agricultural land or the construction of an industrial plant, the cost of the investment is deducted from the increase in value, and the rate is applied to the difference. In estimating the increase in value, the corps warns its investigators not to use existing land values as compared to future land values since that method would ignore the increases or decreases in value that would occur regardless of flood control. Instead, they are to use estimated future values with and without the flood-control program.

### NAVIGATION

In estimating the benefits from navigation and the associated costs of navigation, the Bureau of Reclamation and the Federal Power Commission either obtain estimates from the Corps of Engineers or else, when necessary, make their own estimates using the same method. The agencies of the Department of Agriculture usually do not evaluate navigation benefits in monetary terms.

*Inland waterways*

The Corps of Engineers recognizes five types of direct benefits resulting from the development of inland waterways.

(1) Benefits accrue to businesses that reduce their shipping costs by using the waterway instead of a more expensive alternative method of transportation. The benefits credited to the project are equal to the savings to the shipper.

(2) If the development of a resource has previously been blocked by isolation or by the high rates of other types of carriers, benefits will result if the development is made possible by the waterway. In measuring the benefits, a hypothetical rate at which development would be possible is established. The benefit is the difference between the hypothetical rate and the actual rate by waterway.

(3) Benefits may result from improvements on existing waterways which lower operating costs. The benefits are equal to the number of units (such as ton-miles or ship-transits) multiplied by the average saving per unit.

(4) The construction of a project that connects with an existing waterway may attract existing traffic or develop new movements for the longer haul. The benefits are the estimated savings of the complete waterway movement. All of the savings are assigned to the new waterway.

(5) In some cases, a new project will divert traffic from an existing waterway. The only benefits credited to the new project are the additional savings that its use makes possible.

All of the benefits have the assumption that the savings on the waterway are passed on from the operator to the shipper and from the shipper to the consumer. In measuring benefits from waterways, the corps recognizes that competing carriers may reduce their rates; in most cases, however, the corps believes that it is impractical to predict the extent and effect of the rate cutting.

The associated costs of a navigation project are the investment and operating costs of the shipowner. The corps assumes that the rates he charges will cover these costs. Since the benefit is the difference between the rate by the cheapest available alternative and the rate by the waterway, the associated costs are accounted for in the computing of the benefit.

*Harbors*

The benefits from the construction and improvement of deep-water harbors are the savings to operators and shippers. Usually, the method of measurement is the same as for inland waterways. In some cases, however, the corps believes that harbor improvements will yield large benefits which are difficult to measure monetarily, but which it considers obviously outweigh the project costs. In such cases, no attempt is made to measure the benefits quantitatively. Direct monetary benefits from small-boat harbors result from recreation, discussed under incidental functions, and from commercial use. The benefit from the increase in a fish catch resulting from harbor improvements is measured by deducting the increase in operating costs, such as labor, from the increase in the value of the catch. Benefits to other small commercial craft are reductions in operating costs, prevention of damage, reduction of transportation charges, and similar savings.

### HYDROELECTRIC POWER

Benefits may accrue from the development of hydroelectric power in a multiple-purpose project. The Bureau of Reclamation, the Corps of Engineers, and the Tennessee Valley Authority are all agencies that build multiple-purpose projects. The Federal Power Commission also evaluates the benefits from hydroelectric power as part of its function as a reviewing agency on projects that include power. The Department of Agriculture does not usually measure the power benefits of its watershed programs in monetary terms.

The Bureau of Reclamation defines direct power benefits as the expected gross revenues from the sale of power produced by the plant. If the transmission lines are included in the cost of the project, the revenues are those realized at the load center where the power is marketed; otherwise, the value of the power is measured at the project site. An additional power benefit may result from increases in usable energy at downstream power plants due to the regulation of stream flow by the project. Sometimes the construction of a project will result in the decrease in power production at an existing plant. This may be caused by the diversion of water for other purposes or by the flooding of an existing plant by the project. The value of the decrease in power production is subtracted from the benefits. All the costs of power are project costs.

The Corps of Engineers uses the measurement methods of the Federal Power Commission. The direct benefit from power is based on the cost of producing an equivalent amount of power by the most economical alternative method available, usually a steam-electric plant. Adjustments are made for the differences in transmission costs, transmission losses, system efficiency, and similar factors. The project is credited with increases at downstream plants as well as at the project site.

The difference between the two methods of computing the direct benefits of power lies in the manner in which the agencies handle the saving from cheaper power. The Bureau restricts the direct benefit of power to the gross revenues received for power. The saving is counted as an indirect benefit. The other two agencies, who define the direct power benefit as the cost of the cheapest available alternative, are actually combining the receipts to the Government with the saving from cheaper power. This may be seen from the fact that the saving from cheaper hydroelectric power is the difference between the cost of the power from the alternative steam generation and the cost of power from hydroelectric system.

### INCIDENTAL FUNCTIONS

A multiple-purpose project will generally include several incidental functions in addition to the major functions. Prominent among these incidental functions are recreation, fish and wildlife conservation, pollution abatement, domestic and industrial water supply, sedimentation control, and salinity control.

*Recreation.*—Generally, the Corps of Engineers measures tangible recreation benefits by estimating the net income from recreational facilities, such as hotels, camps, and concessions. The Bureau of Reclamation obtains estimates from the National Park Service. The

Department of Agriculture does not measure any tangible recreational benefits.

*Fish and wildlife.*—All agencies obtain estimates from the United States Fish and Wildlife Service.

*Pollution abatement.*—All agencies determine pollution-abatement benefits by estimating the cost of the most practical alternative method of abatement that would be used in the absence of the project.

*Domestic and industrial water supply.*—All agencies usually measure the benefits from water supply as equal to the cost of most practical alternative method of providing water. Occasionally the benefit will be the charge that the water users are willing to pay.

*Sedimentation control.*—All agencies measure sedimentation control benefits on the basis of damage prevented and on the basis of prolonging the life of a facility such as a reservoir.

*Salinity control.*—Salinity-control benefits are measured by all agencies on the basis of damage prevented. The method of measurement is the same used in measuring flood damages.

## Indirect Benefits and Costs

### THE PROBLEM OF INDIRECT EFFECTS

The indirect benefits and costs of a project are the effects that the project has on the economy of the Nation. Indirect benefits accrue to the secondary activities stemming from or induced by the project, such as the industries that process, distribute, or consume the products of the project and such as the activities that supply the project area with goods and services. The indirect costs are the values necessary to realize the indirect benefits. The purpose of including the indirect effects of a project in an economic evaluation is to give a clearer picture of the economic results of a project.

The measurement of indirect benefits and costs is a relatively new concept derived from the Flood Control Act of 1936 which uses the phrase "all benefits to whomsoever they may accrue." Previous to that, the existence of such effects was known, but little or no attempt was made to measure them quantitatively. Because it is a new concept, the agencies do not agree among themselves on certain points. They differ on the definition of an indirect benefit and an indirect cost, on the method of measuring indirect effects, and the use to which the indirect effects should be put.

The function for which indirect benefits and costs are measured are: (1) irrigation (by the Bureau of Reclamation only), (2) hydroelectric power (by the Bureau only), and (3) flood control (by the Corps of Engineers, the Bureau of Reclamation, the Federal Power Commission, and the Department of Agriculture).

### IRRIGATION

The indirect tangible benefits of irrigation are considered to arise from the increased sale of farm products and from the increased demand for goods and services by the project. The indirect tangible costs are the values consumed by the secondary activities. Included are the costs of processing and distributing the irrigation products and of making goods and services available to the project. In order to calculate the net secondary benefits, the indirect costs are deducted

from the indirect benefits. The Bureau of Reclamation combines the calculation of net indirect benefits with the measurement of gross indirect benefits and indirect costs into one operation by means of the indirect benefit factors. The factors were derived by calculating the contribution of each type of economic activity to the national income. The contribution of an activity is the amount of income produced, such as wages and salaries, rents, interests, and profits before income taxes.

The indirect benefits in the processing and distributing activities that are credited to the project arise from the increased production of farm products. For the purpose of illustrating the working of the indirect benefit factors, 4 crop groups were selected from the Bureau's list of 10 groups. The following figures show the factors for the four crops at the various stages of processing and developing and the total factor for each crop.

| Activity | Livestock | Fruits and vegetables for canning | Grains | Cotton |
|---|---|---|---|---|
| | *Percent* | *Percent* | *Percent* | *Percent* |
| Merchandising | 8 | 9 | 8 | 18 |
| Direct processing | 9 | 21 | 12 | 31 |
| Other stages | 3 | | 23 | 41 |
| Wholesale trade | 7 | 15 | 10 | 10 |
| Retail trade | 28 | 29 | 30 | 24 |
| Total | 55 | 74 | 83 | 124 |

The factors are applied in the following manner: If there is an increase of $10,000 in the production of grains on the project, the net secondary benefit would be $1,000 (10 percent of $10,000) for the wholesale trade in grain and $12,400 (124 percent of $10,000) for all secondary activities.

The project is also credited with secondary benefits arising from local trade. Again, for the purpose of illustrating the application of the factors, 6 types of local businesses were selected from a Bureau list of 19. The factors for the six are shown in the following:

| Business | Factor | Factor applied to increase in— |
|---|---|---|
| | *Percent* | |
| Retail trade (purchases from) | 12 | Value of goods purchased. |
| Wholesale trade (purchases from) | 3 | Do. |
| Auto garage and repair | 29 | Value of service purchased. |
| State and local government | 31 | Value of State and local taxes (excluding State income tax). |
| Motion-picture theaters | 39 | Value of admissions paid. |
| Business services | 49 | Value of services purchased. |

The factor is applied as follows: If purchases from a retail store rise (or are assumed to rise) $5,000 as a result of the project, the net indirect benefit credited to increase in farm production is $600 (12 percent of $5,000).

The application of the "indirect benefit factor" to gross increase crops gives the indirect benefits resulting from the total of all costs, both Federal project and private farm costs. In order to credit the Federal project costs with only their appropriate share of indirect benefits, the Bureau has devised a "Federal cost-adjustment factor."

This factor is determined by deducting the increase in farm costs from the increase in gross farm income and dividing the remainder by the increase in gross farm income.

If the "Federal cost-adjustment factor" is multiplied by the indirect benefits derived by use of the "indirect benefit factor," the product will be the net indirect benefits from a project commodity that are credited to the Federal project costs.

An example of the calculation for the net indirect benefits credited to the project costs can be developed using the figures for grain.

1. Assume $10,000 as the value of the increase in the production of grain, which is also the increase in gross farm income; then, using the figures already developed, $12,400 is the value of the indirect benefits in the processing and distributing stages.

2. Assume $7,600 as the value of the indirect benefits to local trade, and $8,000 as the increase in gross farm costs.

3. The indirect benefits credited to the project costs are as follows:

(*a*) Total indirect benefits:

| | |
|---|---|
| (1) Indirect benefits to the processing and distributing trades | $12,400 |
| (2) Indirect benefits to local trade | 7,600 |
| Total indirect benefits | 20,000 |

(*b*) Federal cost-adjustment factor:

$$\frac{\$10,000-\$8,000}{\$10,000}=\frac{\$2,000}{\$10,000}=\frac{1}{5}$$

(*c*) Net indirect benefits credited to the project costs:

$$\$20,000\times\frac{1}{5}=\$4,000$$

### HYDROELECTRIC POWER

The indirect benefits of electric power arise from the distribution and the final utilization of the power. For the purposes of analysis, the Bureau of Reclamation has established two groups of secondary power benefits: (1) those from power sold to utilities for resale, and (2) those from power sold directly to the final consumer by the Bureau. The total indirect benefit of power is the sum of the two.

There are three types of benefits in the first group. The first of these is the saving in production costs to the utility purchasing the power for resale. The saving is assumed to be passed on to the consumer. The benefit is equal to the difference between what the utility pays the Bureau for power and the cost of an equivalent amount of power produced by the cheapest alternative method, usually by steam generation. This benefit, counted as an indirect benefit by the Bureau, is included in the direct benefit of power by the Corps of Engineers and the Federal Power Commission. Those two agencies define the direct benefit of power as the cheapest available alternative method of production, while the Bureau defines the direct benefit of power as the revenue received from the sale of power.

Indirect benefit of the second type is the benefit accruing through retail distribution of power that the Bureau has sold to a utility. The benefit is the sum of the annual return on investment plus State and Federal income taxes. The annual return was derived in two steps: (1) the average net rate of return on investment was estimated, and (2) the ratio of the net rate of return to the gross revenue was computed.

Indirect benefit of the third type in the first group is the benefit resulting from the use of Bureau power resold by the utility in the final production of goods and services.

The second group of indirect benefits arise from the sale of power directly to the consumer by the Bureau. The first type within this group is the saving to the consumer because of the lower rates charged by the Bureau. It is counted as part of the direct benefits of power by the Federal Power Commission and the Corps of Engineers.

Benefit of the second type corresponds to the same type benefit in the first group, the benefit to the power company as a result of its distribution of Bureau power. Since the power in this group is distributed by the Bureau directly to the consumer, this second type benefit is not counted.

Benefit of the third type corresponds to benefit of the third type in the first group. In this case, the benefit arises from the utilization of power sold directly by the Bureau in the production of goods and services. The ratios of profits to costs, developed in step (3) of the first group, are applied to the cost of the power to the industrial and commercial users.

### FLOOD CONTROL

Indirect benefits from flood programs are measured by the Corps of Engineers, the Bureau of Reclamation, the Department of Agriculture, and the Federal Power Commission. Indirect flood losses consist of the net loss of goods and services to the Nation as a result of the flood and the cost of flood fighting. The major item in the first category is loss due to the interruption of business and commercial activity. The net loss is the value of the goods and services that would have been produced, but, because of the flood, are permanently lost. The corps measures the value of the loss as the difference between the gross value of the goods or services and the value of the materials used in the operation. The loss of wages is included in the difference. In measuring the effects, only those losses which cannot be compensated for or avoided by any action other than flood control are counted. Included as part of this general category are also the losses resulting from the spoilage of stock. The measurement is cost of replacement.

Included as costs of flood fighting are the costs of evacuating and caring for flood victims, emergency flood-protective work, and the increased cost of carrying on business during the flood. All of these are measured directly by field investigations.

### COMMENT

There are three general questions to be raised about the Bureau of Reclamation method of measuring indirect benefits and costs.

At the present time, the national economy is operating at a high level. Such a situation seems likely to continue for several years. Since in a high-level economy there is great demand for labor, capital, and materials, those which are used in a project would also have use elsewhere—in private industry, for example. This use elsewhere would also result in indirect benefits and costs in the economy of the Nation. The Bureau of Reclamation computation method, however, appears to assume that the resources used in the project have no use elsewhere. It counts all the indirect effects from the use of the resources, not just the additional indirect benefits and costs resulting

from the use of the resources for the project instead of for some other purpose.

In its calculation of ratios to be used in calculating the indirect benefits and costs, the Bureau of Reclamation uses statistics for the Nation as a whole although the projects lie in the 17 Western States.

The Bureau counts, as an indirect benefit, profits before taxes, thus including taxes as a benefit.

### FEDERAL INTERAGENCY RIVER BASIN COMMITTEE

The Federal Interagency River Basin Committee has tentatively suggested a method of measuring indirect benefits that differs from the Bureau of Reclamation method. Briefly, the interagency method is as follows:

(1) The gross indirect benefits and costs with the project are estimated.

(2) The indirect costs are subtracted from the indirect benefits, yielding the net indirect benefits.

(3) The percentage of unemployment of labor that is expected at the time the project is to be built is estimated. This percentage is adjusted for the locality and the specific conditions pertaining to the project.

(4) The amount of resources that would not be used unless the project would be built is estimated. This is based in part on the percentage derived in step (3).

(5) The difference between the direct benefits and the project costs is computed.

(6) The difference in net income is secondary activities with and without the project is computed by multiplying the net indirect benefits as derived in step 2 by the sum of the amounts derived in steps 4 and 5, divided by the net direct benefits.

The purpose of this method of calculation of indirect benefits is to rule out the indirect benefits that would have occurred if the resources were used in an alternative way, and, thus, to count only the income in the secondary activities that results from the use of the resources for the project.

### Benefit-Cost Ratio

All agencies use the methods suggested by the Federal Interagency River Basin Committee for predicting future price levels. For agricultural prices, the level is based on a report of the Department of Agriculture which postulated three levels of employment—high, medium, and low. For each level, the report projected the level of prices, income, and other indicators of economic activity. Using the general price level associated with the high-employment conditions, the Department of Commerce projected the prices of nonagricultural products.

The agencies vary in the maximum period of analysis that is used in making an economic evaluation. The Federal Power Commission sets 50 years as the absolute maximum. The Corps of Engineers sets 50 years as the maximum, but, actually in some cases allows a longer period. The Bureau of Reclamation sets 100 years as the maximum. Of course, in the case of all three agencies, if the estimated life of the

project is less than the maximum period of analysis allowed, the life of the project is used as the period of analysis.

The agencies differ in their calculations of benefit-cost ratios. The Corps of Engineers and the Bureau of Reclamation compute the average annual benefits, direct and indirect, and subtract from that the average annual associated and indirect costs. The result is the average annual net benefit. In computing the benefit-cost ratio, the average annual net benefit is compared with the average annual project costs. The Department of Agriculture, however, sums up all average annual benefits and all average annual costs; the two are then compared.

### Intangible Benefits and Costs

Intangible benefits and costs are project effects that cannot be measured in monetary terms, but are to be evaluated qualitatively. Intangible benefits cover a wide range of items. An irrigation project may provide new economic opportunities, aid in improving the national diet, or stabilize the economy of an area. A power project may provide a more dependable source of power, serve families previously without electricity, provide power for defense industries, or conserve scarce fuel. A flood-control project may have the intangible benefits of saving human life and preventing the personal and community disruption that accompanies floods. The intangible costs, which are the adverse effects of a project, also cover a wide range of possible items. Families will be uprooted if their land is flooded by a reservoir. Recreational values such as scenery, wildlife, or wilderness, may be damaged or destroyed by a project. A farming community may have its life unsettled by becoming a construction boom town for a few years. The national defense may be hindered by the diversion of scarce materials and labor from defense industries to nonessential projects.

The intangible effects of a project have a definite place in economic evaluation. The intangible costs may make a project undesirable, even though it has a favorable tangible benefit-cost relationship. The intangible benefits of a project may be so great as to outweigh an unfavorable relationship. In evaluating the intangible effects much care must be taken so that neither too much nor too little weight is given them.

## SPECIFIC PROJECTS

While the preceding discussion compares the procedures of the agencies as set forth in their manuals of instruction, the subcommittee believes that a concept of the problems involved can readily be obtained from examination of the economic evaluations presented to Congress in a few recent reports.

### Dauphin Island Bay, Fla.

Dauphin Island Bay, Fla., is a shallow inlet about three-fourths of a mile wide and 1.75 miles long on the mainland side of Dauphin Island. The northwestern end of Mobile Bay opens into Mississippi Sound which lies between Dauphin Island and the mainland. The island lies 3 miles south of the mainland.

There is an authorized project, upon which no work has as yet been done, which provides for a 7-foot channel, from Mobile Bay to an anchorage the same depth just north of the eastern tip of Dauphin Island and a 4-foot channel from the basin to the 3-foot contour in Dauphin Island Bay. The project also provides for construction of a jetty to protect the entrance channel on the north, if found advisable, to reduce maintenance dredging costs.

There is a small unmaintained anchorage just north of the island, constructed by the Coast Guard during World War II, which is used as a harbor of refuge by small craft.

Local interests originally proposed a 10-foot channel from Mississippi Sound to a 200-foot-square anchorage basin the same depth near Dauphin Island Village, later accepting a 7- or 8-foot channel as adequate.[2] Other local interests proposed a channel from Mississippi Sound to Mobile Bay via Dauphin Island Bay to accommodate commercial vessels drawing 6 or 7 feet. This would provide a shorter protected route from Mobile Bay to the Gulf; Dauphin Island Bay then constituting a harbor of refuge for small boats operating on the Gulf.

Beneficiaries of the proposed improvement would be the 226 inhabitants of Dauphin Island Bay Village, all of whom are engaged in sea-food production, providing them with increased safety and security. It was stated by local interests the project would encourage establishment of sea-food processing plants, shipbuilding and repair facilities, recreational facilities, and would facilitate transfer of sea foods to freight boats.

In light of the request of local interests, the Corps of Engineers studied two possible plans.

Plan A: Consists of a channel from Mississippi Sound, to a 7-foot anchorage basin, 500 feet square, along the shore of Dauphin Island Bay in the vicinity of Dauphin Island Village.

[2] H. Doc. No. 394, 82d Cong., 2d sess.

| | |
|---|---|
| Initial costs (all Federal): | |
| Dredging channel | $36,000 |
| Dredging basin | 20,000 |
| Total to Corps of Engineers | 56,000 |
| Navigation aids (Coast Guard) | 6,700 |
| Total initial cost | 62,700 |
| Non-Federal costs | None |
| Total | 62,700 |
| Annual costs (Federal): | |
| Corps of Engineers interest, at 3 percent | 1,900 |
| Amortization, 3 percent, 50 years | 600 |
| Maintenance | 6,000 |
| Coast Guard: Maintenance | 400 |
| Total Federal | 8,900 |
| Non-Federal | None |
| Total | 8,900 |
| Annual benefits: | |
| Channel, 9,450 boat hours, at $2.20 per hour | 20,800 |
| Harbor no monetary value | |
| Total annual benefits | 20,800 |

Ratio, benefits to cost: 2.34.

Plan B: Consists of a similar but longer channel, from Mississippi Sound to the western end of the presently authorized project channel; enlarging the authorized channel; and a side channel, terminating at an anchorage basin in the vicinity of Dauphin Island Village.

The initial costs, all Federal, are estimated at $118,200, annual costs at $20,300, and annual benefits at $22,100.

The evaluated benefits are based entirely on an estimate of time saving that might be made through the use of the proposed improvement essentially as a refuge. The estimate is based on an assumed number of boats involved, an assumption of the average time that might be lost during each fishing season of a number of boats, an assumption of the average value of catch per hour of trip, and finally an assumption that all time saved would be used for additional fishing and would result in an increase in production at the rate of the assumed average. Such a collection of assumptions leads to an estimate of benefits which is certainly not too firm. While the estimate of cost of the work should be relatively sound, the benefit-cost ratio must be taken only as a general indicator of merit and not a firm measure.

It is to be noted that the annual costs of plan A amount to approximately $30 per boat involved and the annual benefits approximately $70 per boat. It would appear that in view of the concentrated benefits and relatively small cost that if the anticipated benefits were firm the beneficiaries would be willing to make some cash contribution toward the project.

While the estimate of benefits is probably as sound an estimate as can be made, its reduction to a monetary value and ultimately to a benefit-cost ratio may tend to indicate a validity that is not warranted by the assumptions.

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## Belhaven Harbor, N. C.

The town and harbor of Belhaven, N. C., are on the left bank of Pantego Creek, a tributary of Pungo River, 130 miles south of Norfolk. The harbor comprises the lower 6,000 feet of Pantego Creek. There is a completed existing project, which provides a 12-foot channel, 100 feet wide from deep water in Pungo River to a point 800 feet below a highway bridge a mile and a half above the mouth; a turning basin at the upper end of the channel 300 feet wide and 800 feet long; and timber breakwaters at the mouth of the creek.

Local interests requested a study of the possibility of improving the breakwaters, claiming that storms caused waves that bypassed the breakwaters and did considerable damage to commerce and water-front structures in the harbor. They also suggest the construction of a 10-foot channel 1,200 feet long to provide a safe harbor for small vessels using the Intracoastal Waterway and connecting channels.

The Corps of Engineers in the course of its survey considered several possible solutions to the problem of protection of shipping in Belhaven Harbor, including improvement of channel, construction of new stone or timber breakwaters nearer to the commercial water front (including destruction of present breakwaters), improvement of present breakwaters either by sand dike and riprap or by stone dike, and various combinations of these.

### Calculation of Costs and Benefits (H. Doc. 389, 82d Cong.)

*1. Provision of 10-foot channel in Wynne's Gut, 60 feet wide, with a turning basin*

| | Amount | | Amount |
|---|---|---|---|
| Initial cost: | | Annual costs—Continued | |
| Federal: | | Federal—Continued | |
| Dredging | $10,800 | Amortization, 3 percent, 50 years | $120 |
| Engineering, overhead and contingencies, about 25 percent | 2,700 | Maintenance | 500 |
| Total Federal | 13,500 | Total Federal | 1,030 |
| Non-Federal: | | Non-Federal: | |
| Space for public landing, rights-of-way, etc | 5,000 | Interest, at 3½ percent on $6,250 | 220 |
| Engineering overhead and contingencies, about 25 percent | 1,250 | Amortization, 3½ percent, 50 years | 50 |
| Total non-Federal | 6,250 | Total non-Federal | 270 |
| Total initial costs | 19,750 | Total annual charges | 1,300 |
| Annual costs: | | Annual benefits: | |
| Federal: | | Prevention of damage (75 percent of present annual average damage to boats) | 3,150 |
| Interest, at 3 percent on $13,500 | 410 | | |

Ratio benefits to cost: 2.42.

*2. New breakwaters closer to commercial water front (alternatives: stone or timber)*

| | Stone | Timber |
|---|---|---|
| Initial cost: | | |
| Federal: | | |
| Dike in place (28,600 tons of stone or 33,000 square feet of timber in place) | $314,600 | $165,000 |
| Engineering, overhead, and contingencies (25 percent for stone, 35 percent for timber) | 110,110 | 57,750 |
| Total Federal initial cost | 424,710 | 222,750 |
| Non-Federal: | | |
| Furnishing rights-of-way | 500 | 500 |
| Engineering, overhead, and contingencies, at 25 percent | 125 | 125 |
| Total non-Federal initial cost | 625 | 625 |
| Total initial costs | 425,335 | 223,375 |
| Annual costs: | | |
| Federal: | | |
| Interest, at 3 percent | 12,740 | 6,680 |
| Amortization, 3 percent, 50 years | 3,770 | 1,975 |
| Maintenance | 2,500 | [1] 6,135 |
| Total Federal | 19,010 | 14,790 |
| Non-Federal: | | |
| Interest, at 3½ percent | 20 | 20 |
| Amortization, 3½ percent, 50 years | 5 | 5 |
| Total non-Federal | 25 | 25 |
| Total annual costs | 19,035 | 14,815 |
| Annual benefits: | | |
| Prevention of damage to water front and wharves (based on abandonment of present breakwaters), 70 percent of damage to water front | 3,010 | 3,010 |
| 50 percent of damage to boats | 2,350 | 2,350 |
| Savings from nonmaintenance of present breakwater | 3,000 | 3,000 |
| Total annual benefits | 8,360 | 8,360 |

Benefit-cost ratio: 0.44 for stone breakwaters; 0.56 for timber breakwaters.

[1] Maintenance and operation on timber breakwater calculated as follows:

| | |
|---|---|
| Increased maintenance | $2,000 |
| Interest, 3 percent, on $103,390 (present worth of $222,500 in 25 years) | 3,190 |
| Amortization, 0.887 percent of $.05,3.0 | 945 |
| Total maintenance and operation | 6,135 |

This is a complex calculation that reduces the amortization period from 50 to 25 years. While the result is the same numerically, the shorter period might better have been used originally.

*3. Improvement of present breakwaters, including dike and extensions*

| | Sand dike and riprap | Stone dike |
|---|---|---|
| Initial costs: | | |
| Federal: | | |
| Dike in place | $19,525 | $246,800 |
| Riprap in place | 41,375 | None |
| Timber extension in place | 17,500 | 17,500 |
| Engineering, overhead, and contingencies, about 35 percent | 27,440 | 92,500 |
| Total Federal initial cost | 105,840 | 356,800 |
| Non-Federal | None | None |
| Annual costs: | | |
| Federal: | | |
| Interest, at 3 percent | 3,175 | 10,705 |
| Amortization, 3 percent, 50 years | 940 | 3,165 |
| Increased maintenance | 2,500 | 2,000 |
| Total Federal | 6,615 | 15,870 |
| Non-Federal, 3½ percent, 50 years | None | None |
| Total annual costs | 6,615 | 15,870 |
| Annual benefits: Additional damage prevention to boats, wharves, and waterfront property | 1,000 | 1,000 |

Benefit-cost ratio: 0.15 for sand dike and riprap; 0.06 for stone dike.

Costs and benefits were also calculated for various combinations of channel improvement and breakwater improvement, but in no case did annual benefits equal the annual costs. The only instance in which the benefit-cost ratio was favorable was for the channel improvement alone and the Corps of Engineers recommended that such improvement be carried out.

In considering direct benefits it was found that there were no readily ascertainable savings in shipping costs. It was considered that there would be a net increase of activity in the port, especially of smaller craft, because of the channel improvement which would provide a harbor of refuge for such craft.

As a side light on this study it is to be noted that the direct cost to the engineer district concerned for the survey was $5,800. This excludes costs borne by the division engineer, the Chief of Engineers, the Board of Engineers for Rivers and Harbors, the Bureau of the Budget, and congressional committees. Cost of printing the report was $662.87 (965 copies). Thus a direct expenditure of $6,463 has been made for a report recommending a project estimated to cost $13,500.

## Sakonnet Harbor, R. I.

Sakonnet Harbor, R. I.,[3] is an inlet situated on Sakonnet River, three-fourths of a mile north of Sakonnet Point in the southwestern part of the town of Little Compton, R. I. It lies on the east side of the entrance to the river from the Atlantic Ocean. The harbor is 15 miles by water east of Newport Harbor, 12 miles southwest of Westport Harbor, and about 28 miles southwest of New Bedford Harbor.

The harbor is roughly rectangular in shape, shallow, rock-bound and open on the north.

The east shore of the Sakonnet River extends almost due north for 1.5 miles and then swings northwest to Church Point, which is about 2,000 feet west of the harbor. To the northwest the nearest land is Acquidneck Island which is across the river and 3 miles away. The harbor is exposed to storms from the north and northwest, which is the direction from which the dominant storm winds come.

The present project provides for a breakwater 400 feet long, 15 feet wide at the top at an elevation of 8 feet above mean low water, and for removal of the rock nearest the breakwater to a depth of 8 feet at mean low water. The project was completed in July 1900, and the rock removed in July 1908.

There are four wharves in the harbor, one, the Sakonnet Yacht Club on the east side, and three adjoining each other on the west side. None are publicly owned but are open to the public free of charge for taking on supplies and making shore contact. A State highway provides access to all wharves. There are no shipbuilding or repair yards or marine railways.

The improvements desired by local interests to provide additional anchorage space and give safety are: an extension of the existing breakwater of about 400 feet in a northeasterly direction, the dredging of the harbor to a depth of 8 feet, and the removal of a rock pile left from previous dredging operations just east of the existing breakwater.

[3] H. Doc. No. 436, 82d Cong., 2d sess.

*Costs and benefits*

| | |
|---|---|
| Initial cost: | |
| Federal Corps of Engineers: | |
| Dredging: | |
| 8 feet deep, 43,000 cubic yards, sand and gravel, at $1.50 | $64,500 |
| 8 feet deep, 6,000 cubic yards, ledge, at $30 | 180,000 |
| Construction of breakwater extension, 30,000 cubic yards stone in place, at $8 | 240,000 |
| Coast Guard: Steel tower and fixed light in place | 11,400 |
| Total Federal initial cost | 495,900 |
| Non-Federal: Local interests, cash contributions | 18,700 |
| Net Federal cost | 477,200 |
| Annual costs: | |
| Federal: | |
| Corps of Engineers: | |
| Interest at 3 percent | 13,970 |
| Amortization, 3 percent, 50 years | 4,130 |
| Maintenance | 1,000 |
| | 19,100 |
| Coast Guard: | |
| Interest | 340 |
| Amortization | 100 |
| Maintenance | 300 |
| | 740 |
| Total Federal annual costs | 19,840 |
| Non-Federal: | |
| Interest, at 3½ percent | 650 |
| Amortization, at 3½ percent, 50 years | 145 |
| Total non-Federal annual costs | 795 |
| Total annual costs | 20,635 |

Annual benefits:

| | General | Local |
|---|---|---|
| Elimination of vessel damage, all types | $3,000 | |
| Increased benefits to local fishing fleet, winter fishing and new boats | 37,125 | |
| Increased benefits to outside fishing vessels, savings in transportation costs | 275 | |
| Increased benefits to local recreational fleet: | | |
| Transferred boats | 490 | $490 |
| New boats | 930 | 930 |
| Transient boats | 290 | 290 |
| | 42,110 | 1,710 |
| Total annual benefits | 43,820 | |

Benefit-cost ratio: 2.12.

NOTE.—Unit costs include allowance for engineering and overhead, but not for contingencies.

This proposed project is said to provide protection from winter storms, prevent damage from those storms, and provide increased anchorage space. In calculating the benefits to be derived several items appear of doubtful validity.

The estimated benefit of $3,000 for damage prevention is based on the experience of 11 years during which only two storms occurred for which there was any calculation of damages. Total damages for this 11-year period were calculated at $44,800. This figure is based largely on personal statements by port interests who are interested in obtaining the project.

Dredging the harbor and construction of the breakwater would increase the available anchorage space. At present there are 66 vessels based in the harbor, 25 of which are fishing vessels. In calculating the benefits at $40,820, most of them ($37,125) were credited to increased fish catch. This figure appears overly generous. There are no available records of the present catch upon which to base such

a calculation. The increase is arrived at by estimating a present catch of 5.5 million pounds, or 220,000 pounds per boat for approximately 9 months. Additional catch would result from 10 of the present fleet engaging in winter fishing, transfer of 10 vessels from other harbors during the winter months, and construction of 6 to 8 new boats to be added to the present fleet. The additional catch is calculated at 2.25 million pounds at an average value of 1.65 cents per pound. No allowance is made for increased costs of fishing in winter, and the number of days when fishing would not be possible. This latter is important since one of the principal reasons advanced for the entire project is the prevalence of heavy winter storms. Present estimates of increase are equal to the entire year's catch of 15 vessels. It should be pointed out that the catch of the transferred vessels, which event is not entirely certain, would not constitute a net gain to the Nation since it would be counteracted by the losses sustained by the ports from which transfer was made.

Various benefits are calculated as accruing to the recreational vessels which might use the improved harbor. These are calculated on the basis of additional use of 12 vessels which would transfer to the harbor from other harbors, construction of 30 additional boats, and additional use of the harbor by transients. Total of such benefits are calculated to be $3,420.

Should all of the vessels use the harbor as claimed by local interests the harbor would be just as crowded as it is now. This estimated crowding appears necessary to provide the high figure of estimated benefits. It is noteworthy that there is not at present and there is no certain prospect of any ship repair and storage facility.

The report proposes a contribution by local interests of $18,700, but it is not clear how this figure was determined. It can be considered low in light of the general local nature of benefits.

## Rice Creek, Putnam County, Fla.

Rice Creek [4] is a tributary of the St. Johns River, located in Putnam County, Fla. It rises 12 miles northwest of Palatka, and, flowing easterly for 10 miles, enters the St. Johns River 3½ miles north of Palatka and 52 miles south of Jacksonville. It drains about 320 square miles of generally low and swampy terrain, subject to tidal and flood overflow.

The entrance to Rice Creek is partially obstructed by a sand shoal (6.6 feet controlling depth). Approximately 2.2 miles above the mouth the creek narrows from 200 feet to 80 feet at about the point where Etonia Creek joins it from the northwest. Rice Creek is crooked with very sharp bends in the vicinity of the United States Highway 17 bridge, about 1 mile above the mouth. Approximately 0.4 mile above the mouth of Etonia Creek the Hudson Pulp & Paper Corp. has dredged an access channel from Rice Creek for a distance of 1,400 feet, 10 feet deep and 90 feet wide. This extends in a southerly direction to a turning basin at the corporation's mill. This was completed in 1946 at a cost of $40,000.

No previous study of any improvement of Rice Creek has been made. There is a completed project for St. Johns River, from Jacksonville to Lake Harney, with varying depths.

Present commerce on Rice Creek consists of towed barges carrying principally in-bound fuel oil for the Hudson Corp. It is made difficult

[4] H. Doc. No. 446, 82d Cong., 2d sess.

by the crooked channel, which is full of debris and sharp turns, and during 2 months of the year is grown over with waterchestnuts.

Local interests requested improvement of Rice Creek to provide a safe, navigable waterway from the project channel in St. Johns River to the access channel of the Hudson Corp., to include easing and straightening sharp bends in the creek, and provide more horizontal clearance at the two bridges. The only beneficiary would be the Hudson Pulp & Paper Corp. since the area immediately tributary to the proposed improvement is sparsely settled, barren, and swampy. The only apparent possibility of additional commerce is that some pulpwood not readily accessible to other means of transportation might reach the market by water. There are at present no public piers or wharves along Rice Creek. The Hudson Corp. extends the privileges of its access channel and turning basin to whomever might wish to use it without cost.

The plan of improvement resulting from the study by the Corps of Engineers provides for a 12-foot channel, 100 feet wide from beacon 64 in St. Johns River to the mouth of Rice Creek, and thence 75 feet wide to the access channel of the Hudson Corp., except through the railroad bridge where the horizontal clearance could be increased to 38 feet through both draws, and through the highway bridge where existing widths of 41.7 and 41.0 feet would be retained. A widened approach would be provided at the south land point between the bridges to accommodate tows 400 feet long, a cut-off would be made across the land point west of the highway bridge; and necessary straightening, widening, and snagging would be done at other places. Some low-value, privately owned swamplands would be required for rights-of-way and spoil-disposal areas.

Calculations of costs and benefits are as follows:

| | |
|---|---|
| Initial costs: | |
| Federal: | |
| Corps of Engineers: | |
| Clearing (12 acres), snagging, and dredging (236,000 cubic yards) ½ of total $136,300 | $68,150 |
| Coast Guard (navigation aids) | 1,800 |
| Non-Federal: | |
| Local interests: ½ of construction costs | 68,150 |
| Lands for rights-of-way and spoil-disposal areas | 1,050 |
| Total initial costs | 139,150 |
| Annual costs: | |
| Federal: | |
| Interest at 3 percent | 2,098 |
| Amortization at 3 percent, 50 years | 620 |
| Maintenance (Corps of Engineers, $600; Coast Guard, $250) | 850 |
| Total Federal annual cost | 3,568 |
| Non-Federal: | |
| Interest at 3½ percent | 2,422 |
| Amortization at 3½ percent, 50 years | 528 |
| Allowance for loss of taxes on lands transferred to Federal ownership | 12 |
| Total non-Federal annual costs | 2,962 |
| Total annual costs | 6,530 |
| Annual benefits: | |
| Annual transportation saving on 65,000 tons of pulpwood | 18,200 |
| Annual transportation saving on 26,000 tons of fuel oil | 5,200 |
| Total annual benefits | 23,400 |

Benefit-cost ratio: 3.58.

The Corps of Engineers noted that "principal" benefits would accrue to local interests and recommended they contribute one-half of initial construction costs.

The Florida State Board of Health called attention to the problem of water pollution which had arisen from the disposal of wastes from the mill of the Hudson Corp. The United States Fish and Wildlife Service also noted that water pollution was affecting fish and wildlife, not only in the Rice Creek area but in the St. Johns River and suggested that the corporation be required to take measures to ameliorate the condition before the project be carried out.

Local interests expressed willingness to cooperate insofar as pertaining to lands and rights-of-way and holding the United States free from damages. The Hudson Corp., however, did not agree and were reported as unwilling to bear one-half of the construction costs as recommended by the Corps of Engineers, when the report was made by the district engineer to the Board of Engineers for Rivers and Harbors. At a hearing held by the Board of Engineers at the request of the Hudson Corp. the latter expressed its desire that entire costs of the project be borne by the Federal Government. The corporation gave as its reasons that they had already made large contributions to navigation by dredging a channel, by agreeing to replace the obstructive fender system of the railroad bridge, that many benefits would accrue to other local interests as well as the town, county, and State and, finally, that it would need to enlarge their basin and terminal facilities and provide lands and rights-of-way at a cost in excess of that estimated by the district engineer. It further claimed that similar improvements had been made for the benefit of some of their competitors at no cost to them. Subsequently, the corporation informed the Board that they are willing to contribute to the fullest extent required.

In considering the direct benefits to be derived, savings in transportation costs were noted for two commodities, fuel oil and pulpwood. However, in the report it was noted that no pulpwood had as yet moved. The belief that one-third of the Hudson Corp.'s annual needs for this commodity would so move is advanced as the basis on which 77 percent of prospective benefits are founded. Improvement of Rice Creek would permit the use of larger barges for the transport of fuel oil at a saving of 26 cents per ton over the present operations using smaller barges.

No benefits are claimed for movement of other commodities, although should all commodities used by the Hudson Corp. as well as the outbound products of the plant utilize the waterway as suggested it would amount to a total potential additional traffic of 61,000 tons. Little evidence is presented to indicate that such movement will eventuate. The area served by Rice Creek, and particularly the plant of the corporation, is well served by four railroads and a number of Federal and State roads.

It would seem difficult to make a case for national benefits for this project. This is recognized by the Corps of Engineers in recommending that the project not be built unless local interests, in this case a single corporation, bear one-half of the construction costs. It appears fairly obvious that the present conditions will continue. That is, the only commerce on the entire waterway is for the benefit of that corporation. In addition, the corporation has not at any time seemed

very willing to bear even the one-half share of costs of construction. The statement that there will be a national benefit from any transportation savings made possible by the project through the passing along such savings to the public will not bear close scrutiny.

The entire question of water pollution is treated rather summarily in the report. Note is made of the protests of the State of Florida authorities, United States Public Health Service, and of the National Fish and Wildlife Service of the pollution caused by the corporation. These agencies have suggested that this be disposed of before serious consideration is to be given to construction of the project.

## Hackensack River, N. J.[5]

The Hackensack River, N. J., is a short river, 45 miles in length, roughly paralleling the Hudson River. The mouth of the river is in Newark Bay, at Jersey City, and via Kill Van Kull gives access to upper New York Bay, and via Arthur Kill and Raritan Bay to lower New York Bay. The existing project provides a channel of 35 feet in Newark Bay to Port Newark terminal, a 30-foot channel of varying widths to 2,000 feet north of the Delaware, Lackawanna & Western Railroad bridge, thence a 12-foot channel to the New York, Susquehanna & Western Railroad bridge at mile 16.5. The river is navigable for 21 miles to a dam at New Milford.

Local interests proposed improvements of the Hackensack, in addition to the present completed project, consisting of a turning basin for deep-draft vessels, deepening of existing 30-foot channel to 35 feet, widening of bend in 30-foot channel, deepening of existing 12-foot channel to 30 feet through and beyond the town of Secaucus, widening of upper end of 12-foot channel, removal of wreck, and construction of mooring area for pleasure boats.

The Corps of Engineers reported on five plans, which included most of the proposals by local interests.

Plan 1: Deepening of present 30-foot channel to 32 feet, widening at bends, and a turning basin at the upper end of the 30-foot channel.

| | | |
|---|---|---|
| Initial cost, Federal: | | |
| Corps of Engineers (excavation) | | $1,463,000 |
| Coast Guard (navigation aids) | | 800 |
| Initial cost, non-Federal: | | |
| Local interests | | 49,000 |
| (Deepening of approaches and berths) | $29,000 | |
| (Relocation of utilities) | 20,000 | |
| Total initial costs | | 1,512,800 |
| Annual costs, Federal: | | |
| Maintenance | | 10,100 |
| Interest at 3 percent | | 43,910 |
| Amortization at 3 percent, 50 years | | 12,980 |
| Total Federal | | 66,990 |
| Annual costs, non-Federal: | | |
| Interest at 3½ percent | | 1,710 |
| Amortization at 3½ percent, 50 years | | 370 |
| Total non-Federal | | 2,080 |
| Total annual costs | | 69,070 |

[5] H. Doc. No. 252, 82d Cong, 1st sess.

*Annual benefits*

| | |
|---|---|
| 1. Deepening of channel to 32 feet and widening bends: | |
| (*a*) Savings of 5.5 hours' delay for 150 trips at $70 per hour | $57, 800 |
| (*b*) Reduction of damages due to shipping accidents | 24, 000 |
| Total | 81, 800 |
| 2. Turning basin of 25 feet: | |
| (*a*) Savings of 1 hour delay, for 150 trips at $70 per hour | 10, 800 |
| (*b*) Reduction of damages due to shipping accidents | 8, 000 |
| Total | 18, 800 |
| Total annual benefits | 100, 600 |

Benefit-cost ratio: 1.46.

Plan 2: Deepening channel of present 30-foot channel to 33 feet, widening at bends and turning basin at upper end of 30-foot channel.

| | |
|---|---|
| Initial cost, Federal: | |
| Corps of Engineers | $1, 682, 000 |
| Coast Guard (navigation aids) | 800 |
| Total Federal | 1, 682, 800 |
| Initial cost, non-Federal: | |
| Deepening approaches and berths | 45, 000 |
| Relocation of utilities | 270, 000 |
| Total non-Federal | 315, 000 |
| Total initial costs | 1, 997, 800 |
| Annual costs, Federal: | |
| Maintenance | 10, 100 |
| Interest at 3 percent | 50, 480 |
| Amortization at 3 percent, 50 years | 14, 920 |
| Total Federal | 75, 500 |

*Annual benefits*

| | |
|---|---|
| 1. Deepening channel to 33 feet and widening bends: | |
| (*a*) Savings of 5.5 hours, 150 trips at $70 per hour | $57, 800 |
| Savings of 5.5 hours, 5.5 trips at $100 per hour | 3, 100 |
| (*b*) Reduction of damages due to shipping accidents | 26, 000 |
| Total | 86, 900 |
| 2. Turning basin of 25 feet: | |
| (*a*) Savings of 1 hour, 150 trips at $70 per hour | 10, 800 |
| (*b*) Reduction of damages due to shipping accidents | 8, 000 |
| Total | 18, 800 |
| Total annual benefits | 105, 700 |

Benefit-cost ratio: 1.19.

The recommended improvement, plan 1, recognized the serious traffic congestion, resulting in cramped quarters, and the current trend of traffic utilizing the waterway toward use of larger vessels. At the same time it would seem that the lesser degree of improvement, 32 feet rather than 33 or 35 feet, was adequate since additional savings at the latter two depths were not commensurate with added costs.

Records presented by several companies of accident damages and losses appear to be sufficient to justify the turning basin. However,

it is not clear how the annual savings are derived. From the evidence introduced of one recent accident, it would seem that one such accident per year would account for the entire estimated savings. Again, from the evidence presented by 1 company of 12 accidents over a period of 17 years with total damages, actual and through loss of use of the ships of over $164,000, it would seem that the estimate of benefits was conservative in this respect.

The 25-foot turning basin appears justified because of the characteristics of the traffic utilizing the 30-foot channel. Since all vessels which would use it are to return empty, that depth would appear to be sufficient.

Annual benefits for improvement of the 30-foot section would seem to be based on avoiding, at present costs, one major accident a year. The lump sum of $8,000 as annual benefits from the turning basin appears to be based on elimination of several minor accidents. These estimates appear to be conservative if traffic conditions are as reported.

The recommended improvements involve only dredging and removal of rock. Cost estimates apparently are reasonable. Local interests will be required to bear what appears to be a fair share of costs, both initial and for maintenance. This includes all relocation of utilities.

The question as to justification of the project in light of the President's letter of July 21, 1950, to the Secretary of the Army would seem to preclude immediate construction of this project since no large volume of defense industries are affected with the possible exception of the Federal Shipbuilding & Drydock Co., which might benefit from the widening of the channel at the sharp bend just downstream from its yard.

A case might be made for it on the strength of the need for power by industry within the area which is dependent upon the waterway for its fuel supply at the two generating plants (Kearney and Marion stations). No such evidence of need for immediate action is contained in this report.

The lesser proposals were clearly not justified and were rejected.

The costs and benefits of the work proposed by local interests appear to have been well and reasonably evaluated in this study.

### Brazos River Watershed, Texas [6]

In its survey report the Department of Agriculture has recommended a program of watershed improvement and flood control for the Brazos River Basin, to be installed over a 15-year period. Total cost of the program is estimated at $109,065,000, of which the Federal Government would be responsible for $69,084,000, other public agencies for $9,578,000, and local interests for $30,403,000.

The program is divided into two parts. The first calls for land-treatment measures for soil-erosion prevention, runoff and water-flow retardation by means of terraces, field diversions, crop cover, new grasslands, fire protection, and improved land-management practices. It calls for shaping and stabilization by vegetative cover of farm and group waterways and gully stabilization. Technical services will be made available for planning and applying the necessary land-use adjustments, for planning and applying land-treatment measures on

[6] Brazos River and tributaries, Texas. Program for Runoff and Water Flow Retardation and Soil Erosion Prevention. U. S. Department of Agriculture. January 1951. (House Doc. 396, 82d Cong., 2d sess. March 20, 1952, and unpublished appendixes.)

farm and ranch lands and for integrating the measures included in the recommended program. Educational assistance is to be provided to inform those of the basin of the measures and the assistance available to them.

The second type of measures included in the program consist of construction of floodwater retardation reservoirs, and channel and floodway improvements of tributary streams.

Local interests are expected to operate and maintain the program after it is fully installed. Annual operation and maintenance costs are estimated at $9,552,000, of which $9,355,000 is to be borne by local interests for maintaining land-treatment measures and for increased cost of operating the changed system of conservation farming. Local interests acceptable to the Secretary of Agriculture will be called upon to make an annual expenditure of $189,500 for operating and maintaining installations not considered a part of farm and ranch operations. The remainder, $7,500, is to be expended by the Federal Government for maintaining a system of fire protection.

Annual benefits of $31,035,000 to be derived from this program are estimated at $5,690,000 in flood damages prevented, and $25,345,000 in additional income from improved conservation farming methods.

## DESCRIPTION OF THE REGION

The Brazos River is formed in the high plains of New Mexico near Aspermont, and flows in a southeasterly direction to the Gulf near Freeport, Tex. Only that portion in Texas is considered in this survey. The river drains an area of 44,080 square miles, of which 41,997 are in Texas.

The economy of the basin is primarily agricultural, 42 percent of the watershed is cropland, 45 percent is open grassland, 7 percent is pastured woodland, and the remainder is in varied uses. Much of the western portion is subject to prolonged droughts, severe winds, and water erosion. Grasslands are generally unimproved and overgrazed. About three-fourths of the precipitation falls during or immediately before the growing season.

There is an authorized program by the Corps of Engineers for flood control, navigation, and power. This consists of eight reservoirs, channel improvements, and levees. The Department of Agriculture's program is predicated on the completion of the corps' program and benefits contemplated in this survey report are stated to be in addition to such as will accrue from the program of the Corps of Engineers when completed.

## THE PROBLEM

Eleven major floods have occurred in the Brazos River Basin on the main stream in the period from 1899 to 1944. The majority have occurred during the spring growing season, only two having occurred during the winter months.

In the Brazos Basin the two principal causes of floods are general storms and thunderstorms. The former usually cover a large portion of the watershed, causing flooding of the main stream and of the tributaries. Thunderstorms are more frequent, are accompanied by intense rainfall, causing severe local damage, but are usually confined to a lesser area and contribute little to major floods, although one or several tributary subwatersheds may suffer severe damages.

The average annual damage within the basin has been estimated as follows:

| | |
|---|---|
| Floodwater damage: | |
| Crops and pasture | $10, 304, 000 |
| Other agricultural | 1, 586, 000 |
| Nonagricultural | 372, 000 |
| Flood-plain scour | 349, 000 |
| Total | 13, 611, 000 |
| Sediment damage: | |
| Deposition of infertile overwash | 199, 000 |
| Reservoir sedimentation | 421, 000 |
| Cost of water treatment | 39, 000 |
| Total | 659, 000 |
| Indirect damage | 1, 280, 000 |
| Total average annual damage | 14, 550, 000 |

The survey report notes that without watershed treatment by some such program as contemplated, that it is expected that flooding would increase in frequency, magnitude, and severity in the future. This is due to the progressive deterioration of land cover, increased erosion and runoff, and sedimentation of channels and flood plains.

### EFFECTS OF THE PROPOSED PROGRAM

No information is contained in the survey report as to how the figures used in calculating benefits and costs were determined. However, some such information, together with other background information and other details, are included in a separate volume of appendixes. Discussion of details is based largely on this volume.

The proposed program is for the accomplishment of two main purposes. The first is to mitigate damages caused by recurring floods, and the second to increase agricultural production. The first is to be accomplished primarily by use of water-flow retardation measures and the second by means of improved land treatment and management measures. By far the greater benefits are to be derived from the latter.

### COSTS OF RECOMMENDED PROGRAM

Total initial costs are estimated with technical services, educational assistance, and administrative costs of direct aids allocated to the proper portion of the program, as follows:

| Measure | Unit | Quantity | Cost (1949 prices) |
|---|---|---|---|
| Terraces | Mile | 115, 650 | $21, 036, 000 |
| Field diversions | do | 2, 990 | 1, 229, 000 |
| Cover crops | Acre | 193, 100 | 990, 000 |
| Farm and group waterways | Mile | 5, 240 | 1, 095, 000 |
| Gully stabilization | do | 2, 380 | 3, 904, 000 |
| Establishment of new grassland | Acre | 233, 700 | 9, 244, 000 |
| Improvement and management of existing grassland | do | 3, 782, 900 | 25, 930, 000 |
| Fire protection | do | 500, 000 | 150, 000 |
| Floodwater-retarding structures | Each | 555 | 42, 666, 000 |
| Floodway and channel improvement | Mile | 81 | 2, 821, 000 |
| Total | | | [1] 109, 065, 000 |

[1] Includes 15.6 percent for technical services, hydrologic studies to facilitate program installation, administration of direct aids and educational assistance. Non-Federal public agencies will bear approximately ½ the cost of educational assistance and ¼ the cost of fire protection.

The appendixes indicate that examinations in some detail were made of eight small subwatersheds which in the aggregate approximated 4 percent of the total area under consideration. Extension from this sample in proportion to area then provided the over-all figures.

There is nothing in the appendixes to support the quantity figures given in the preceding tabulation. For example, the discussion on floodwater-retarding structures indicates that an analysis was made of the effect of nine such structures on Mulberry Creek. The report then states: "It appears at the present time that such structures cannot be included economically as a part of the recommended program in Mulberry Creek and similar areas." This discussion of a rejected sample is followed by the statement that table 26 gives general data regarding size, number, and distribution of the recommended floodwater-retarding structures, and goes on to say: "At this stage of planning no designs have been made and quantities and costs were estimated on the following bases." The immediate following paragraph is phrased with verbs in the future tense and indicates nothing about either quantities or costs. The discussion then closes with table 26, which shows the number of proposed floodwater-retarding structures recommended, totaling 555, but nothing concerning the quantity of materials or costs involved. A subsequent discussion, a hundred pages further on, states that surveys of possible floodwater-retarding structure sites were made in 20 sample tributaries within the watershed. Reference is made to the cited table 26 and the only cost statements are that it is estimated that 25 percent or more of the sites required will be furnished by the landowners without cost; that the remaining sites will be provided by local interests "unless it is not feasible for them to do so"; that under such circumstances the sites will be provided at Federal expense; and that the annual maintenance cost during and after the period of installation is estimated to be $200 per structure and is considered a private cost. This discussion is followed by a table showing lump-basis figures but the data are inadequate to provide any check on cost computations. Obviously the cost figures set forth above are not at all firm since the report says that no designs have been made.

Unit costs have been used for some items in the recommended program. However, there is nothing in the report to indicate whether these unit costs are based on experience or solely on estimates. It would appear then that both quantities and costs tabulated above have been made without much, if any, preliminary design background. The total cost then cannot be considered to be a particularly valid figure.

### ANNUAL COSTS

In a discussion in the appendixes headed "Comparison of benefit and cost" appears this paragraph:

> The average annual cost of the recommended program is $12,796,827. The installation costs were converted to an annual base using an interest rate of 2½ percent for public and 4 percent for private costs at 1949 prices. For details of the costs see tables 40 and 41, appendix V.

The table 40 shows installation costs totaling $108,539,105. Table 41 shows average annual costs of the recommended program as $5,252,311. This analysis has previously quoted the report proper as

stating the annual operation and maintenance costs are estimated at $9,552,000. There is no reconciliation of these three figures of average annual cost in either the report or the appendixes, but it appears that the following approximates the facts:

| | |
|---|---|
| Annual operation and maintenance costs | $2, 007, 180 |
| Annual equivalent of installation cost | 3, 245, 131 |
| Net increase in farm operating expenses | 7, 544, 507 |
| Total | 12, 796, 818 |

The annual equivalent of installation cost includes interest on installation cost plus amortization of construction costs of floodwater-retarding structures over a 100-year period. The interest rates used are 2½ percent for public investment and 4 percent for private investment. This means that of the total estimated installation cost, $108,539,105, only $42,666,420 is amortized.

It would appear more conservative to decrease the amortization period to a maximum of 50 years for structures of a permanent or semipermanent nature and to amortize the other improvements over a lesser period such as 25 years. While interest rates of 2½ percent for Federal investment and 4 percent for private investment seem reasonable, it is considered that some rate between the two, such as 3½ percent, would be preferable for use in connection with the non-Federal public investment. Even in this more conservative approach, the amortization of the initial cost of cover crops, technical services, educational assistance, and administration of direct aids is of questionable propriety. Since a 15-year program is proposed, it would seem more reasonable to charge these items off as expense over that period. Arithmetically each of these two apparoaches that are suggested as more conservative than the one used by the Department of Agriculture results in an increase in the amount to be charged to annual equivalent costs of approximately $1,600,000.

The figure of $2,007,180 as a charge for annual operation and maintenance of the installations does not appear unreasonable although it may prove to be low, particularly since it includes an allowance of only $200 annually per structure for maintenance of 555 retarding dams.

There are no supporting data for the estimate of increased farm expenses totaling $7,544,507.

## BENEFITS

This analysis is directed essentially to the economic evaluation. Accordingly, it is considered generally out of place to discuss engineering features of the proposed plan. However, since flood-control benefits consist of potential flood damages eliminated, and since flood damages are a function of stream flow and its related rainfall, it is particularly pertinent to note that the entire study has been made with a marked paucity of hydrologic and meteorologic data. While the records are meager, there is nothing to indicate that either probable flood damages or potential flood-damage prevention benefits have been underestimated by the Department of Agriculture. However, even if these benefits estimated at $5,690,000 annually are perhaps optimistic, they constitute only 18.3 percent of the total estimated average annual benefit from the proposed program.

The great bulk of anticipated benefits, $25,345,497, are conservation benefits expected to accrue to landowners and operators. This figure is perhaps the most vulnerable in the entire computation. Its realization is dependant not only upon the installation of the whole proposed program but also in some shift in land use. There is, of course, a considerable question as to how effectively a change in land use will be brought about when the lands are in private ownership.

Apparently, the Department's calculated estimates of increased yield due to conservation were well tempered by judgment. Table 57 is entitled "Comparison in Increases in Yields of Selected Crops as a Result of Conservation Farming, as Shown by Records, With Increases Used in Evaluation of the Recommended Program." The table shows figures for three crops in each of two conservation-problem areas. The record indicates that cotton crop increased by 35 percent and 29 percent, and the figures used in the evaluation are 35 percent and 21 percent. On the other hand, although conservation records show that oats increased 19 percent, the figure 0 was used in the evaluation; and, while the records show that sorghum increased 61 percent, the figure used in the evaluation was 10.5.

There is no breakdown in the data included in the appendices to show what portion of the conservation benefits would accrue from increased yield due to conservation practices and what portion would accrue from increased yield resulting from changed land use.

In summary, the economic evaluation appears to use figures both in estimated costs and in estimated benefits that are not at all firm. A large proportion of the expenditures are intended to go for flood-retarding structures, yet the preponderance of benefits are expected to accrue as conservation benefits in the nature of increased farm receipts to operators. The cost estimates can be criticized for the absence of even preliminary plans and the use of an area-sampling procedure for estimating the need for structures. The estimated benefits are based on sketchy extensions of hydrologic data, estimates of changed land use, and increased farm yield. While the stated figures show estimated benefits well in excess of estimated costs, the calculations, the assumptions, and their presentation do not inspire confidence. The real economic value of the program is left in doubt.

The examination of this particular report, which is typical of 10 referred to the Committee on Public Works since the closing day of the first session of the Eighty-second Congress, indicates most strongly that the proposal is essentially one of land treatment and soil conservation. There is no solid proposal that approximates the customary project for the construction of what is normally considered public works. There appears to be even the possibility that a large part of the conservation benefits can be realized without the expensive construction items.

### Collbran Project, Colorado [7]

The Collbran project, reported upon by the Bureau of Reclamation, Department of the Interior, was authorized for construction by Public Law 445, Eighty-second Congress. The project will provide water for approved irrigation, hydroelectric power, recreational benefits, and fish and wildlife benefits. Consideration of the report at this point is solely to provide a ready-reference example of economic evaluation

[7] H. Doc. 216, 82d Cong., 1st sess.

procedure used by the Bureau of Reclamation for ready comparison with the immediately preceding examples set forth in this report.

The Collbran project area is located in Mesa County, Colo., about 170 miles west of Denver. The Grand Mesa, jutting from the west slope of the Continental Divide and rising to 10,300 feet, is the principal landmark of the region. Its northern slope is dotted with many small natural lakes and is drained by numerous streams tributary to Plateau Creek, which is in turn a tributary of the Colorado River.

Plateau Creek, flowing westward from the northwest slopes of Grand Mesa, forms Plateau Valley, approximately 20 miles long and from less than a mile to 8 miles wide, and from 5,500 to 7,000 feet in elevation. Project lands south of and in a narrow, broken strip the length of the valley will benefit from irrigation water.

Grand Valley, northwest of the mesa, is traversed by the Colorado River, flowing westward into Utah from its source on the western slope of the Continental Divide. The river enters the valley a short distance above the town of Palisade and flows west to join the Gunnison River at Grand Junction, thence northwesterly through the valley, which is 41 miles long, and from 4,500 to 4,850 feet in elevation.

The report proposes that runoff of two Grand Mesa streams, Big and Cottonwood Creeks, would be diverted by pipeline as a supplemental municipal and domestic water supply for Grand Valley. The steep drop to the valley from its origin would be utilized to produce approximately 51,600,000 kilowatt-hours of firm power and 6,670,000 kilowatt-hours of nonfirm power annually. A minimum flow of 20 second-feet would be maintained year round by storage regulation in the Bonham Reservoir on Big Creek and eight small natural lakes on the upper reaches of Big and Cottonwood Creeks. Surplus spring runoff from upper Plateau, Leon, and Park Creeks would be stored until needed at Vega Reservoir. This water would be used to replace the water diverted to Grand Valley, which is at the present time used for irrigation in Plateau Valley. Regulation of water at Vega Reservoir would serve to provide about 15,900 acre-feet of water annually as a new irrigation supply for 20,650 acres of land in Plateau Valley, including 2,310 acres now idle for lack of water and 18,340 acres now inadequately irrigated. Bonham Reservoir on Big Creek, enlarged to a capacity of 6,300 acre-feet, a nearly sixfold increase, would be utilized for municipal and power supplies. The water in this reservoir would be collected from the Big and Cottonwood Creek watersheds by two canals: the East Fork feeder canal, 30 second-feet in capacity and 1.1 miles in length; and the Cottonwood feeder canal, 15 second-feet in capacity and 2.1 miles in length. The pipeline conducting the water thus collected would be 44 miles in length and would also receive water from Big Meadows Reservoir, one of the small natural lake basins on Cottonwood Creek. Two interconnected power plants would be constructed along the pipeline to make use of the natural drop. One power plant would be located near Molina (5,000-kilowatt capacity) and the other near Cameo (2,400-kilowatt capacity). Power supplies would be delivered near the lower or Cameo plant for distribution. Municipal water would be delivered to an equalizing reservoir that would be constructed by the water users about 4 miles northeast of Grand Junction.

The elements of the project works are indicated in the tabulation of estimated capital costs.

INITIAL COSTS

*Estimated capital costs*

| | |
|---|---|
| Vega Dam and road relocation | $2,605,000 |
| Leon-Park feeder canal | 337,000 |
| Bonham Dam and appurtenant works | 1,787,000 |
| East Fork feeder canal | 27,000 |
| Cottonwood feeder canal | 63,000 |
| Southside canal | 1,864,000 |
| Pipeline and penstock | 3,537,000 |
| Power plants and appurtenant works | 1,511,000 |
| Service roads for power and domestic features | 23,000 |
| Fish screens | 3,000 |
| Investigations and surveys (reimbursable funds) | 28,000 |
| Operating equipment and operation and maintenance during construction | 45,000 |
| Undistributed engineering and overhead | 353,000 |
| Valley pipeline below power plant No. 2 | 1,116,000 |
| Total initial capital costs | 13,299,000 |

Capital costs of the various project elements have been allocated to individual purposes by averaging the results of the priority-of-use and alternative-justifiable-expenditure methods.

The total cost of $13,299,000 at current prices is exclusive of nonreimbursable expenditures from Colorado River development funds for investigations and surveys. Costs of recreational-facility development are not included, as they would be the responsibility of other agencies.

*Allocation of construction costs*

| | Priority-of-use method | Alternative-cost method | Average |
|---|---|---|---|
| Irrigation | $4,026,000 | $3,948,000 | $3,987,000 |
| Power | 6,281,000 | 6,345,000 | 6,313,000 |
| Municipal and domestic uses | 2,735,000 | 2,749,000 | 2,742,000 |
| Fish and wildlife | 257,000 | 257,000 | 257,000 |
| Total | 13,299,000 | 13,299,000 | 13,299,000 |

REPAYMENT

Capital costs allocated to irrigation, power, and municipal water would be reimbursable. Power and municipal-water revenues over a 60-year period and irrigation-water users over a 50-year period will contribute to the repayment of initial costs.

Municipal and domestic users would be called upon to pay $86,680 annually for 60 years to amortize the capital costs allocated to that portion of the project at 2-percent interest and including operation and maintenance costs of $7,800. The interest component, $1,991,000 in 60 years, would be paid into the United States Treasury.

Revenues accruing from sale of electric energy at 5.6 mills a kilowatt-hour for firm and 3 mills for nonfirm energy would total $308,960 annually. This revenue would pay all operation, maintenance, and replacement costs ($80,000 annually), amortization costs at 3-percent interest, and leave a balance of $139,000 at the end of 60 years. The interest component, amounting to $7,285,000 in 60 years, would be

used in part to assist in payment of the irrigation allocation. Should firm power be sold for 6 mills per kilowatt-hour for the first 6 years of operation and 5.5 mills thereafter, it would also repay power allocation in 60 years. Should all firm power be sold at 5.5 mills, however, 64 years would be required for repayment.

A 3-year development period from completion of the irrigation facilities is considered desirable to allow irrigators to prepare and improve their lands for operation under the project during which irrigation would pay only operation, maintenance, and replacement costs. On completion of this period water users would pay $20,000 annually toward capital costs and $21,000 operation and maintenance costs. During the 50-year-repayment period this would repay $1,000,000 of irrigation allocation. The remaining $2,987,000 of irrigation costs would be repaid from 41 percent of the interest component of power allocation. Should the repayment period be limited to 40 years assistance from power-interest component would have to be $3,187,000 or 44 percent.

### ANNUAL COSTS

Useful life of the project is estimated at 100 years. However, many of the project works such as pipelines, power facilities, bridges, head gates, and canal turn-outs would require periodic replacements for efficient operation.

Annual equivalent values were determined by the costs of amortization of the initial cost of project development over a 100-year period at 2½ percent interest, allowance being made for interest costs during construction and salvage value of structures useful at the end of the 100-year period. The annual equivalent costs thus determined, including capital cost of full recreational development by the National Park Service of $179,300, amounts to $364,700.

Costs of operation, maintenance, and replacement over a 100-year period are based on average prices during 1939–44 (power at current prices). Replacement costs were calculated on a sinking fund basis at 2½ percent interest over a 100-year period. Total costs for these purposes were estimated at $118,100. Total average annual costs then total $482,800.

In addition other indirect costs would be incurred such as increased investment by local interests in capital equipment, labor, operation, and maintenance, and larger-scale business. No monetary costs were included for these items as they were considered as a negative benefit in computing national benefits.

| *Average annual costs* | |
|---|---|
| Annual equivalent costs<br>(Amortization of initial costs, 100 years at 2.5 percent; interest during construction; salvage values of structures useful after 100 years; full recreational development.) | $364, 700 |
| Operation, maintenance, and replacement costs<br>(100-year period (average 1939–44 prices); power elements at current prices; replacement on sinking fund basis at 2.5 percent over 100 years.) | 118, 100 |
| Indirect costs<br>(Increased private capital costs for equipment, labor, operation, maintenance, and larger scale business.) | 0 |
| Total | 482, 800 |

## BENEFITS

*Irrigation*

With project development, adding 15,900 acre-feet to the present irrigation supply, 2,310 acres of new land can be developed for alfalfa and forage crops and presently developed lands will produce greater yields. It is anticipated that construction of the project will permit a 45-percent increase in production of farm feeds. This in turn will maintain an additional 3,400 head of beef cattle. In addition, the number of dairy cattle maintained is expected to increase and herd quality to improve as more producers qualify to sell market milk. Also increased supplies of skim milk will be utilized for increasing the number of hogs. These calculations are based on the availability of an additional 0.8 acre-foot of water available to now irrigated land and correlated with acreage yields in similar areas receiving full water supply. Increased farm revenues are estimated to amount to $200,300.

The two hydro plants proposed in this project are designed to take advantage of the natural drop of the domestic and municipal water line bringing water from Grand Mesa to a point near Cameo on the Colorado River.

Plant No. 1, with installed capacity of 5,000 kilowatts, would generate 30,600,000 kilowatts of firm energy, 6,670,000 kilowatts of nonfirm energy annually with a constant flow of 20 second-feet, and an excess flow during the spring runoff and during hours of daily peak demand.

Plant No. 2, utilizing a constant flow of 20 second-feet, would have an installed capacity of 2,400 kilowatts, and generate 21,000,000 kilowatt-hours of firm energy. This plant would be suitable for automatic operation. All of the power generated at these two plants can be absorbed by existing utilities in the immediate vicinity of the plants.

Gross receipts from the sale of power at the rates of 5.6 mills for firm and 3 mills for nonfirm power are estimated at $308,960. This will fully repay all power costs and provide a surplus of $139,016 at the end of the sixtieth year. The interest component, calculated at 3 percent for 60 years, and operation, maintenance, and replacement costs of $80,000 annually would be taken care of. Interest would amount to $7,285,584, enough to pay $2,987,000 toward the irrigation allocation and return $4,298,584 to the United States Treasury. Initial construction costs of $6,313,000 will be reimbursed.

## MUNICIPAL AND DOMESTIC WATER SUPPLY

The project would provide water for domestic and municipal use in Grand Valley. Local interests would be required to supply an equalizing reservoir and distributive facilities. In calculating the benefits the alternative-cost method is used since in the absence of the project the municipalities involved would have to construct equivalent works. Previous studies for them have indicated the cheapest alternative method of procuring an adequate water supply was one utilizing the water of the Colorado. This would, however, require extensive treatment to equal project water in quality.

A total of 3,350,000,000 gallons will be available, although only an average of 2,670,000,000 will be needed during the first 50 years. This average supply would cost approximately $203,500 annually to include water treatment, pumping, and amortization of construction costs over 100 years at 2½ percent interest. Revenues are estimated at $86,680 annually.

OTHER BENEFITS

The Fish and Wildlife Service has estimated, as a result of a separate investigation, that the project will provide a net annual gain of $9,300 in fish and wildlife resources as a result of the project. An annual value of this amount, capitalized at 3 percent interest over a 60-year period, would constitute a total of $257,000 in nonreimbursable construction costs.

*Annual benefits*

DIRECT

| | |
|---|---|
| Irrigation: | |
| Estimated increase in annual income: | |
| Receipts from sale of produce | $189, 500 |
| Farm privileges | 10, 800 |
| Total income from farm | 200, 300 |
| Increase in annual expenses: | |
| Interest costs | 16, 300 |
| Hired labor | 18, 500 |
| Other expenses (seed, fertilizer, fees, etc.) | 21, 400 |
| Total increased expenses | 56, 200 |
| Net direct benefits to farmers | 144, 100 |
| Direct benefits to others (interest, labor) | 34, 700 |
| Total direct annual benefits | 178, 800 |
| Power: | |
| Annual revenues from power: | |
| Sale of firm power (51,600,000 kilowatt-hours, at 5.6 mills) | 288, 960 |
| Sale of nonfirm power (6,670,000 kilowatt-hours, at 3 mills) | 20, 000 |
| Total direct power benefits | 308, 960 |
| Domestic and municipal water supply: Alternative cost of facilities | 203, 500 |
| Fish and wildlife benefits | 9, 300 |
| Recreation | 15, 600 |
| Total direct annual benefits | 716, 060 |

INDIRECT

| | |
|---|---|
| Irrigation: | |
| Processing and merchandising of increased agricultural products | 115, 600 |
| Increased local sales of goods and services | 45, 000 |
| Total indirect irrigation benefits | 160, 600 |
| Power: | |
| Savings in production cost to utilities purchasing power from the Bureau for resale and assumed to be passed on to the consumer | 74, 590 |
| Proportionate share in the retailing utilities benefits arising from resale of Bureau power to ultimate consumer at higher rates | 155, 920 |
| Proportionate share in the increased value of goods and services from utilization of Bureau power | 21, 230 |
| Total indirect power benefits | 251, 740 |
| Intangible: | |
| Enlarged agricultural industry, better standard of living, increased employment, industrial development, contribution to atomic energy program, and community development | 0 |
| Total indirect and intangible benefits | 412, 340 |
| Total average annual benefits | 1, 128, 500 |
| Benefit-to-cost ratio: 2.34 | |

## Tuttle Creek Dam and Reservoir, Kans.

The economic material selected for analysis in this example is a study made by local interests to determine the economic losses expected to result from the improvement. It illustrates an error of double counting of a type which whether used in computing costs or benefits can seriously mislead those accepting the results.

The Blue River Study Association, with the assistance of the Chamber of Commerce, Manhattan, Kans., made a study of costs to the community which would result from the construction of the proposed Tuttle Creek Reservoir. The results of the study were published in 1944, and as revised in 1947, and as further revised in 1951. The 1951 revision includes a number of arithmetical inconsistencies which would bring into the following discussion elements tending to create confusion to the reader and to bring unwarranted discredit to the basic study. Therefore, for the purpose of this example, the 1947 revision is considered.

The concluding paragraph of the study reads as follows:

> In conclusion, members of the association wish to point out that they feel that the cost of the proposed Tuttle Creek Dam would be far greater than its worth. To begin with, it would cost $8,250,000 in farm land, $404,250 in town business concerns, $402,300 in town residences, $1,526,358 in miscellaneous property, and an immeasurable amount of business good will and traditional background. In addition to this, there would be an annual recurring loss of $6,121,233 in farm crops and produce and an annual recurring loss of at least $299,100 in business earning power, besides an annual loss of at least $233,937 from miscellaneous sources. While engineers estimate the cost of the dam to be $68,000,000, a figure which might cover the main initial costs, they apparently have failed to consider the $6,644,270 annual earning power of the valley. Since this annual farm and business loss is a recurring loss, it would accumulate each year. At the end of a relatively short period, 20 years, for example, it would reach $132,885,400, or an amount nearly equal to twice the original cost of the project. And this figure—this loss—will continue to grow forever.

This conclusion is supported by detailed figures set forth in the body of the report. Agricultural losses are stated to include (*a*) the value of farm lands to be taken out of production all or part of the time estimated at 55,000 acres with a value of $8,250,000, and (*b*) the value of farm buildings and permanent fixtures that would have to be abandoned, given at a total of $3,026,556. The conclusion fails to include this latter figure.

If 55,000 acres were needed for the dam and reservoir area, they might be purchased in fee by the Federal Government. If this land were permanently inundated or otherwise completely taken out of production, the full value and cost, $8,250,000, would constitute a loss. If, however, a so-called dry dam were built, a large part of the area could be farmed as is done in reservoir areas of similar structures and the true cost or loss would not be as great as the figure given.

The assumption that the full value of farm buildings and permanent fixtures would be a cost (loss) is extreme. Assuming that these structures could no longer be used for their original purpose and would have to be removed from the reservoir area, there would still remain a salvage value which could probably be realized from the sale of the material. Against receipts for salvage would have to be charged the costs of dismantling and disposal. The net salvage value cannot be estimated from the figures available, but it appears obvious that the assumed loss is the extreme maximum cost.

The losses estimated to occur in the inundated towns amounting to $402,300 in residential property and $404,250 in business property apparently include land, fixtures, and structures. Here again probably some reduction in the figures would be proper to allow for salvage of the material in the structures.

A third category, miscellaneous property, consisting of a gravel plant, Union Pacific Railway losses, and Kansas Power & Light Co. losses, are estimated at $1,526,358. It is assumed that these items consist solely of land, structures, and other fixtures. Here again there would be some salvageable material.

Granting that the dollar estimates are reasonably accurate, the nature of these costs is such that with the exceptions noted they can be considered real costs, or, in the language of the study, losses. The major defect in the presentation lies in the inclusion in the costs of the figures, described below, for annual recurring losses.

An annual recurring loss of $6,121,233 is estimated for 27 items. These consist of 8 groups of livestock, 1 item on profit on livestock, 4 groups of animal products, and 14 categories of crops. The dollar figure used in the report for 26 of these is the market value of the items sold. The remaining item is given as profit on cattle purchased and grown for market. The use of the market value as a measure of cost or loss is inaccurate. In the first place none of the items would actually be destroyed. The maximum loss in any one year would be the increment arising from the use of land exclusive of the original cost of the livestock, its feed, the seed for crops, a charge for equipment used, and the labor involved in developing the product for market. The net annual amount attributable exclusively to the use of land would be considerably smaller than the figure given.

Further, it is improper to use even this small annual return from the land as a cost when the whole capital value of the land is taken as a cost. The annual net return from the land capitalized should give the real value of the land. Here either one figure or the other should be used as a measure of the cost or loss, but not both.

A simple illustration of the point can be obtained by consideration of a dwelling house. Assume the house was valued at $15,000 and was rented for $1,200 annually. If an individual sold the house he would no longer be able to receive the rent, but since he has sold it, it is hardly proper for him to consider the gross rent a loss to him so long as he has received the capital value of the building. He is entitled to either the capital value or the return but not both concurrently.

With the removal of the land from production, the individuals presently concerned with operating that land would be required to devote their labors to efforts in some other area. This would constitute an economic upset in the immediate community but would not result necessarily in any net loss to the whole Nation.

Another recurring loss listed in the study is the earning power of the businesses, estimated at $299,100 each year. This loss is for business ordinarily carried on at five towns which would be inundated. Here again the only amount proper to consider as a cost of the project is the net amount of the earnings resulting exclusively from the use of the facilities, excluding costs of operation, labor, and materials. As with the farm land, this net annual increment has already been included in the capital value in business and residence of the five towns.

The same type of double counting is involved in at least $93,220 of the figure $233,937 based on earning power of the gravel plant and of the Union Pacific Railway. Tax losses from these two plants and other net annual tax losses in the several counties shown as amounting to $130,717 would constitute a loss to the governmental agencies involved that should properly be considered in the complete tally of costs.

The point of this illustration is that in the study's conclusion there is a definite doubling up by including as losses both capital value and annual return when each is a measure of the other. One, not both, is a proper measure of loss. Then, if the annual figure is to be used, it should be a net figure excluding all elements which would not actually be lost or destroyed.

While this example illustrates the exaggeration that can be introduced in computing losses due to a project, it is exactly the same type of error that can be introduced in a study of benefits.

The losses claimed, without duplication, appear to be as follows:

| | |
|---|---|
| 55,000 acres farm land | $8, 250, 000 |
| Farm buildings on lands | 3, 026, 556 |
| Towns and villages | 1, 172, 550 |
| Sand and gravel pit | 75, 000 |
| Total | 12, 524, 106 |

As compared to this figure the Corps of Engineers has estimated:

| | |
|---|---|
| 70,835 acres of farm land, including buildings | $12, 400, 000 |
| Towns and villages | 3, 712, 500 |
| Sand and gravel pit | 90, 000 |
| Gypsum mill | 660, 000 |
| Severance damage | 615, 000 |
| Total | 17, 477, 500 |

Excluded from both of the above tabulations are costs of relocations and tax losses. It would appear, however, that the Federal agency has not underestimated the valid losses claimed by the local group.

## CONSTRUCTION PROGRAM FOR 1953

### RIVERS AND HARBORS

An examination of the data submitted by the Corps of Engineers in connection with its estimate of appropriations for 1953 reveals numerous weaknesses in the present use of the benefit-cost ratio as a measure of economic worth. The program to be financed from the appropriation in "Maintenance and improvement of existing rivers and harbors" includes a number of structures. These items, their location, the year project authorized, the year of initiation of construction, and stated benefit-cost ratio are listed as follows:

| Item and location | Year authorized | Year started | Benefit-cost ratio |
|---|---|---|---|
| Demopolis Dam and Lock, Tombigbee River, Ala | 1945 | 1949 | 1.07 |
| Jim Woodruff Dam, Apalachicola River, Fla | 1945–46 | 1947 | [1] 1.12 |
| Buford Dam, Chattahoochee River, Ga | 1946 | 1950 | [1] 1.12 |
| Chain of Rocks Canal, Missouri River, Ill | 1945 | 1946 | [2] 2.0 |
| Lock 19, Mississippi River at Keokuk, Iowa | 1935 | 1952 | [3] 1.4 |
| St. Anthony Falls, Mississippi River, Minneapolis, Minn | 1945 | 1948 | [3] 1.4 |
| McNary Dam and Lock, Columbia River | 1945 | 1947 | 1.19 |
| The Dalles Dam, Columbia River | 1950 | 1952 | 1.26 |
| Reconstruction locks No. 2, Monongahela River, Pa. and W. Va | 1909 | 1949 | [4] 3.17 |
| Cheatham Dam and Lock, Cumberland River, Tenn | 1946 | 1950 | 1.77 |
| Old Hickory Dam and Lock, Cumberland River, Tenn | 1946 | 1952 | 1.55 |
| Gulf Intracoastal Waterway, Colorado River locks | 1950 | 1951 | 1.5 |
| Chief Joseph Dam, Columbia River | 1946 | 1949 | 1.59 |
| Ice Harbor Dam and Lock, Snake River | 1945 | 1953 | 1.19 |
| Howell Mill Shoals Dam, Coosa River, Ala | 1945 | 1954 | [4] 1.19 |
| Upper Columbia Dam and Lock, Chattahoochee River, Ga | 1946 | 1954 | [1] 1.12 |
| Warrior Dam and Lock, Warrior River, Ala | 1909 | 1954 | 1.27 |
| Celina Dam, Cumberland River, Ky | 1946 | 1954 | 1.25 |
| Fernbank Dam and Lock, Ohio River | 1909 | 1954 | 1.36 |
| Greenup Dam and Lock, Ohio River | 1909 | 1954 | 1.33 |
| New Cumberland Dam and Lock, Ohio | 1909 | 1954 | 1.18 |
| Carthage Dam, Cumberland River | 1946 | 1954 | 1.52 |
| McGee Bend Dam, Angelina River, Tex | 1945 | 1954 | 1.41 |
| Hildebrand Dam and Lock, Monongahela River | 1950 | 1955 | [4] 1.72 |

NOTE.—Reference numbers are discussed in text.

Reference No. 1 is to Jim Woodruff Dam, the Buford Dam, and the Upper Columbia Dam and Lock, all three of which are to be constructed in the Apalachicola, Chattahoochee, and Flint River Basin. All three are assigned a benefit-cost ratio of 1.12. The agency presentation states that this ratio applies to the entire authorized project for the river basin. The assumption is to be made that the three structures are sufficiently integral to make it infeasible to make separate economic studies for each of the structures.

Reference No. 2 is to the Chain of Rocks Canal. The benefit-cost ratio given for this project is actually that of the entire project for the Mississippi River between the Ohio and the Missouri Rivers. This middle Mississippi River project has been in operation for a number of years, and it would seem reasonable to expect that the Chain of Rocks Canal as a separate improvement could be separately evaluated.

Reference No. 3 is to lock 19 on the Mississippi River at Keokuk, Iowa, and to the St. Anthony Falls project. The statement submitted

includes a sentence, "Benefits from the new lock are inseparable from the benefits of the entire upper Mississippi River navigation project including an extension through St. Anthony Falls, Minnesota." Again it does not appear reasonable to assume that the benefits of replacing this lock and those of building the St. Anthony Falls project could not be separately estimated.

Reference 4 concerns the reconstruction of locks 2 and the construction of Hildebrand Dam and Lock, both on the Monongahela River. The justification of the project and locks 2 includes the sentence "Because locks 2 are integral and essential elements of the Monongahela River navigation system, their economics are not separable from those of the system." The justification for the Hildebrand Dam and Lock includes the sentence "Hildebrand Dam and Lock is an integral and essential element of the upper Monongahela River navigation system, and, therefore, its economics are not separable from those of the system as a whole." It appears in this instance that it is considered feasible to compute separately the economics of the upper and the main Monongahela River system but not those of the individual projects.

Reference 5 is another example of the same type in that the justification of the Howell Mill Shoals Dam on the Coosa River presents the benefit-cost ratio of the initial development of the Alabama-Coosa Rivers as the ratio applicable to the structure.

While for the five systems mentioned the Corps of Engineers considers that the economics must be computed for the whole systems and not for individual structures, it is to be noted that the same situation does not hold for other systems which would seem to be equally integral units. The 1953 program listed above includes four structures on the Cumberland River. Certainly the Cumberland River development is just as much an integral operation as is that of the Apalachicola, Chattahoochee, and Flint system; yet, for the Cumberland separate economic studies are feasible for each structure, whereas they are said not to be feasible for each of the structures on the A.-C.-F. system. Again, while it is stated as being not feasible to make separate analyses of the two structures proposed on the Mississippi River, separate analyses have been made of the three structures proposed to be built on the Ohio River. These three Ohio River locks and dams would appear to be units no different functionally from lock 19 on the Mississippi River, and there would not appear to be a sound reason for considering the structures in one system separable and those in another system inseparable.

As a general rule the assumption that a project having a high benefit-cost ratio should take priority in construction over one having a lower ratio would not appear to be unwarranted. Yet, examination of the list shows that the Jim Woodruff Dam, started in 1947, has a ratio of 1.12; the Demopolis dam and lock, started in 1949, has a benefit-cost ratio of 1.07; and the Howell Mill Shoals Dam, proposed to be started in 1954, has a ratio of 1.19. The project with the highest economic ratio is to be last initiated. It would appear that the determination of priority was not based on economic merit. If the benefit-cost ratios are not to assist in determining priority of projects, their use as presently developed is open to question.

FLOOD-CONTROL PROGRAM

A number of weaknesses in the benefit-cost ratio as presently used appear in the justifications submitted for the 1953 flood-control program.

The presentation for Cherry Valley Dam and Reservoir, Calif., estimates annual flood-control benefits for ultimate development as $515,000. The justification states that for initial development benefits amount to about two-thirds of those for ultimate development and that other benefits were not estimated since Federal participation is limited to flood control only. The benefit-cost ratio given is 1.1 for the ultimate development. Neither analysis nor statement of benefits of the particular project presently proposed for Cherry Valley Dam is included.

For the Los Angeles County drainage area project, consisting of 4 large earth-filled flood-control dams, a number of lined channels, and 33 debris basins, a single figure of a benefit-cost ratio of the whole project is included. While construction started in 1935 and will not be completed until after 1958, no attempt appears to have been made to determine economic merit of separable units.

For the central and southern Florida project a benefit-cost ratio is given for a whole comprehensive plan. This comprehensive plan has not been authorized. No economic evaluation of the authorized initial plan is presented.

For the Jemez Canyon Reservoir and Dam, the Chamita Dam, and Rio Grande floodway, a single benefit-cost ratio for the entire flood-control phase of the general comprehensive plan is given. Similarly, a single benefit-cost ratio is given for a system on the Grand (Neosho) River, Okla., consisting of the Pensacola, Markham Ferry, and Fort Gibson projects.

The Trinity River project is broken into three units for purposes of economic evaluation. These are (1) the Benbrook Reservoir and Fort Worth floodway, (2) Garza-Little Elm Reservoir, Grapevine Reservoir, and Dallas floodway, and (3) Lavon Reservoir. Benefits from Lavon Reservoir consist only of flood control and stream-flow regulation; yet the project is to be used for municipal water supply in addition.

While the cited groups of projects are considered as economic units, separate benefit-cost ratios are provided for each element of the Ohio River Basin program and of the Missouri River Basin program.

As these benefit-cost ratios appear, there is no way to identify whether the benefits are exclusively those considered to be direct and primary or whether benefits include indirect and secondary values as well. Doubtless an explanation could be rationalized as to why different approaches have been used on different projects. Nevertheless, it is obvious that these indices do not have the same meaning for each project. As an extreme when it is noted, for example, that the ratio presented for the central and southern Florida project pertains only to an unauthorized comprehensive plan and does not apply to an authorized segment of which the cost has increased over 50 percent since its authorization, the validity and meaningfulness of the whole collection of benefit-cost ratios can be seriously questioned. The only pattern that seems to be traceable throughout the whole 1953 program is that the benefit-cost ratio figures given generally exceed unity.

## METHOD AND PERIOD OF AMORTIZATION

As discussed in the section on current procedures, at the present time the Corps of Engineers places a maximum period of amortization as 50 years and the Bureau of Reclamation 100 years. As shown in table 1, both agencies assume amortization on a sinking-fund basis and in addition provide for interest on the full investment during the life of the project. The Agriculture Department provides no amortization but assumes permanent interest on the investment.

The Engineers Joint Council has offered the following on this subject:

> As the specific method of making actual or hypothetical payments in liquidation of the investment in Federal water developments and in computing their costs, whether or not to be reimbursable to the Treasury, amortization should be on the straight-line basis and involve a period of not more than 50 years.
>
> By straight-line basis is meant that method which involves repayment of the investment in equal amounts determined by dividing the investment by the number of years in the period of amortization. It follows that the charge for the use of the money involved in the investment should apply only to the unpaid balance of the investment.
>
> The straight-line method is recommended because—
>
> (*a*) It gives the taxpayers earlier benefits of repayment; i. e., a greater portion of the repayment occurs during the lifetime of the generation of taxpayers whose taxes contributed to the investment.
>
> (*b*) The straight-line method is more conservative, for during the early life of the project the charge for amortization is greater than for the alternative sinking fund and equal-annual-payment methods, each of the latter being based on compound interest.
>
> (*c*) Writing off the investment more rapidly during the earlier part of the amortization period, there would be less loss in event of unanticipated obsolescence.
>
> The fact that the charge against the project is greater during its early life does not mean that there would be no allowance for the needs of developing the project's business. The latter is a separate problem, reasonably to be solved by adding to the capital investment the amount by which the actual income during the period of development is deficient as compared with requirements of self-support and self-liquidation.
>
> The period of amortization, although recommended to be limited to a maximum of 50 years, should in no case extend beyond the reasonable expectancy of life of the development or its components. There may reasonably be different periods among the several components of a multipurpose development.
>
> The cost of replacing the parts which have a shorter life than the period of amortization might be provided through the setting up of a higher annual rate of amortization for those particular parts. However, with equal propriety and probably greater convenience, the provision for the replacement of such relatively short-lived parts can be met by means of the recommended separate allowance for interim replacements.
>
> The recommended amortization requirement makes unnecessary any allowance for depreciation beyond the provision for interim replacements.

An argument has been presented that, if a public project is properly operated and maintained and if necessary replacements are made from time to time, there is no need ever to amortize the investment. It is stated that so long as depreciation is thus taken care of and the project is retained, the Government's requiring amortization in effect constitutes double financing. The general taxpayer puts up the money for construction and again for amortization.

The subcommittee is not impressed with this argument and notes a major difference between public projects and those financed entirely from private capital. A Federal public project is not expected to pay Federal taxes; it enjoys the use of low rate of interest for money and does not attempt to earn a profit. The amortization computation indicates the extent to which the cost of construction to the general taxpayer can be shifted to project beneficiaries. The subcommittee believes, therefore, that it is sound in evaluating the economic merits of Federal projects to provide for amortization within a reasonable period of time. It considers that for the purposes of study a 50-year period is adequate as a maximum for all amortization, notwithstanding the fact that many such investments, such as channels excavated from rock, levees, and nonmovable parts of large dams, may actually continue to be available for their originally intended purpose for many more years. In light of the present rate of change in our civilization, it does not seem sound to burden taxpayers, as yet unborn, with development projects intended to provide benefits primarily during our lifetime.

Consideration of hypothetical examples will readily illustrate the differences between the straight-line method of amortization recommended by Engineers Joint Council and the compound-interest methods of amortization used by the Federal agencies. Both the sinking fund and the equal-annual-payment methods are based on compound interest and as currently used amount to the same return. The equal-annual-payments method proposes annual amounts for liquidation such that during authorization period the investment plus interest would be repaid. The sinking-fund procedure provides solely for establishing, during the authorization period, a fund equal to the amount of the investment. The Federal agencies using this procedure make an additional charge for interest on the investment, so that the net result of the two procedures is identical in total return. The straight-line method proposes equal annual payments of principal plus interest on the unpaid balance.

Assume, for example, an investment of $100 million to be amortized in a period of 50 years at an interest rate of 2½ percent. A sinking fund to liquidate the capital investment in the time set would require annual payments of $1,025,805.69. Interest at 2½ percent would require an annual payment of $2½ million. Amortization in 50 equal payments would require annual payments of $3,525,805.69, an amount which is equal to the annual payment for the sinking fund plus the payment for interest. During a 50-year period the total cash required of the project by either procedure would amount to $176,290,284.50.

Under the straight-line method, the first year payment would amount to $2 million principal and $2,500,000 interest, a total of $4,500,000. The final (fiftieth) year payment would amount to $2,050,000. During the 50-year period the total amount to interest and principal would amount to $163,750,000.

Assuming that the $100 million investment was to be repaid over a 100-year period at 2½ percent interest rate under either of the compound-interest methods, the annual payments would total $273,118,-787. The straight-line method would require a first year payment of $3,500,000 and a final (one-hundredth) year payment of $1,025,000. The total involved during 100 years would be $226,250,000.

The subcommittee wishes to point out in passing that $100 million repaid with 4 percent interest in 40 years or repaid with 3⅛ percent interest in 50 years will result in a total outlay by the payer of about $200 million. Repayment without interest, as provided by reclamation law for irrigation development, is then roughly equivalent to a 50-percent contribution at the time of construction.

*Comparison of 2 methods of amortization*

| | |
|---|---|
| Principal | $100,000,000 |
| Interest rate | 2½ percent |
| Period | 50 years |

| Amount, cost, or payment | Equal annual payments | Straight line |
|---|---|---|
| First year | $3,524,805.69 | $4,500,000 |
| Fiftieth year | 3,524,805.69 | 2,050,000 |
| Average annual | 3,524,805.69 | 3,255,000 |
| Total, first 10 years | 35,248,056.90 | 42,750,000 |
| Total, second 10 years | 35,248,056.90 | 37,750,000 |
| Total, third 10 years | 35,248,056.90 | 32,750,000 |
| Total, fourth 10 years | 35,248,056.90 | 27,750,000 |
| Total, fifth 10 years | 35,248,056.90 | 22,750,000 |
| Full total | 176,290,284.50 | 163,750,000 |

*Comparison of benefit-cost ratios based on 2 methods of amortization*

[Data taken from preceding computation or assumed]

| | Equal annual payment amortization | Straight-line amortization |
|---|---|---|
| Annual liquidation of investment costs (principal) | $3,524,806 | $3,255,000 |
| Maintenance and operation | $1,000,000 | $1,000,000 |
| Total | $4,524,806 | $4,255,000 |
| Annual benefits | $4,400,000 | $4,400,000 |
| Benefit-cost ratio | .973 | 1.033 |
| Conclusion | (1) | (2) |

[1] Costs exceed benefits.
[2] Benefits exceed costs.

The subcommittee notes that the sinking fund methods are used generally for hypothetical studies in which costs and benefits are reduced to an annual basis. They appear to be the more conservative in that they require a larger average annual payment than does the straight-line method. Thus they produce a lower benefit-cost ratio for the same dollar amounts of capital investment and of benefits.

In the event actual repayments to the Treasury are to be made for the liquidation of any phase of a project, the straight-line method of computation would provide for a rapid and earlier recapture of a larger amount of the principal and interest involved but would ultimately provide for a smaller total payment of funds to the United States. There would appear, therefore, to be some mutual advantage in requiring repayments of the reimbursable share of the multiple-purpose projects to be made on this basis. In this situation the subcommittee concurs with the view of the Engineers Joint Council that the straight-line method of amortization is the more conservative.

Since this report is concerned essentially with economic evaluation of water resource development projects and not directly with the questions of non-Federal participation and reimbursement, these latter subjects are not discussed in detail at this time.

## DISCUSSION

The examination of present practices and procedures in economic evaluation of water resource projects which the subcommittee has made has clearly indicated the absence of uniform approach by the different agencies or even a completely consistent approach by the same agency. It is obvious that the executive branch has failed to bring about adequate coordination in this phase of project formulation. Further, the subcommittee is not at all favorably impressed by present efforts to reduce all benefits and costs to monetary units and ultimately to a benefit-cost ratio. A properly developed benefit-cost ratio can be informative but the present trend seems to be toward development of a figure which would be more deceptive than helpful. Perhaps this effort stems from the erroneous assumption that a benefit-cost ratio in excess of unity would serve as an open sesame for the authorization of a project. If Congress were to rely exclusively on a benefit-cost ratio as a measure of whether or not a project should be adopted, it would be abandoning its responsibilities. Some of the effort to place monetary values on indirect benefits is nothing short of ludicrous. It is time to stop using money and manpower on these refinements that serve only an expedient self-deception.

The nature of some of the computations of the indirect benefits may be handily illustrated by a reference to the Bureau of Reclamation manual. A factor of 39 percent of value of admission paid is prescribed for determining the indirect benefit of a project reflected in the use of motion-picture theaters. The amount actually included in a computation would be subsequently reduced by the application of the so-called Federal cost factor. However, a question may be raised as to the validity of the figure 39 percent as of uniform application to all increases in income of motion-picture theaters regardless of where located in the 17 Western States. If an after-the-fact appraisal were being made of the actual increases the use of the factor would be sufficiently tenuous; when such a factor is applied to an estimated increase in receipts the estimate approaches the absurd. It is the view of the subcommittee that even though those devising these computations may not realize their vulnerability, the higher authorities of the agencies who knowingly approve the use of such dubious factors seem to be deliberately participating in an attempt to mislead themselves if not the Congress and the public at large. The use of such hypothecated benefits in a computation would tend to create doubt in the validity of the entire presentation of the agency.

The purpose of flood control is the prevention of disaster. The purpose of soil conservation is to guard the fertility of our land for future generations. One purpose of irrigation development is to spread the base of our civilization and permit a maximum dispersal of population into the arid and semiarid west. The benefits of these functions cannot be completely reduced to an expression of a benefit-cost ratio.

Obviously the benefit-cost test cannot be used as an exclusive measure of national development. The economic evaluation of a project proposal cannot soundly be reduced to a single arithmetic figure. It is time to stop and reappraise our methods.

Before Congress authorizes an improvement work, particularly one for the development of water resources, it should have available as realistic an estimate as is possible of the probable cost in energy, materials, and money. Cost in energy and materials can be reduced to a dollar basis so that a single figure can represent these costs. In evaluating the cost, however, a look must be taken behind the figure. There may be alternative uses of the energy, the materials, and the funds which would serve the national interests better. This fact is obvious when we consider the use of strategic and critical materials in time of war. It becomes less obvious but it is nevertheless present when we deal with other materials and more peaceful times. An appraisal of alternatives can be set forth in text.

As a part of our business approach, we want to know what the direct material returns from this expenditure will be. These can be reduced to a monetary and time unit comparable with the unit used for measuring costs in energy, materials, and funds. If the returns exceed the costs, we know we will be immediately reaping a material profit. As one measure of the merits of a development, this comparison should be made.

The measurable direct material return—the benefits—should be computed within some fixed limit. The following limits appear reasonable to the subcommittee:

| *Purpose* | *Limit of estimated benefit* |
|---|---|
| Navigation | Savings in transportation cost through use of waterway improvement; value of meeting needs of port growth; elimination of potential damage through accident. |
| Flood control | Elimination of potential damage; net increased return from higher use of protected lands; prevention of loss of life. |
| Drainage, Irrigation | Net increased return from higher use of lands involved. |
| Recreation, Fish and wildlife, Domestic water supply, Industrial water supply | Value not in excess of reimbursable costs allocated thereto. |
| Electric energy | Value not in excess of probable revenue from energy to be produced. |

The benefit-cost measure alone generally will not take account of all costs or all benefits. This fact does not mean either that these additional costs and benefits should not be considered or that an artificial attempt should be made to place a monetary value on them.

The subcommittee has already noted in an earlier report that actual costs of projects have increased because of changes in price, structural and engineering modifications, changes in local needs, inadequacies in planning, unforeseen conditions, and administrative decisions. With all these variables affecting cost estimates and few of them except perhaps price changes affecting benefit estimates, it is obvious that a benefit-cost ratio is not only an estimate subject to change without notice but in all probability an estimate that is sure to change. The figure can be used as a guide; but it is only one guide. It cannot serve as a substitute for sound judgment.

The subcommittee is of the opinion that benefit estimates for use in the determination of a benefit-cost ratio should be limited to the tangible benefits. The costs likewise should be the direct tangible costs. The reduction to a comparable unit of time should preferably be to an annual basis. The investment costs should be amortized over a period not exceeding the life of the item involved and in any event not exceeding a period of about 50 years. A longer period would spread the project costs too far into the future, and the experiences of our own lifetimes have shown that changes are occurring too rapidly to justify spreading the indebtedness incurred in entering upon a project over a greater period of time. Interest rates used in any computation should approximate those actually expected to be incurred and should be set uniformly for the use of all Federal agencies by a directive of the agency responsible for coordination on behalf of the President. Such a formula will develop a benefit-cost figure that would have the same meaning for the proposal of one agency as for the proposal of any other.

The economic evaluation of a project cannot, however, rest with the presentation of the benefit-cost figure proposed or any other single figure. If an agency wishes to supplement this kind of benefit-cost ratio with others it has developed to include indirect cost and benefits and perhaps even intangibles, there might be no objection but there is the danger of creating unnecessary confusion by providing too many figures called benefit-cost ratios. Rather, the indirect costs, indirect benefits, and the intangibles might best be considered in a direct, concise, and pointed discussion. Even though the indirect costs and benefits are not measured in numerical units, if they are real they can be concretely set forth in words. The clear and convincing presentation of intangibles is more difficult, but it can be made.

## CONCLUSIONS AND RECOMMENDATIONS

The subcommittee concludes that one of the most important elements for consideration in connection with any project proposal is the economic evaluation. It is of the opinion that there is no handy formula for measuring the full economic worth of a project in a single arithmetic expression. It appears that present efforts to reduce secondary or indirect benefits to monetary or other numerical evaluations is misleading and, to say the least, is self-deceptive on the part of those using such methods. A benefit-cost ratio determined from an appraisal of estimated direct benefits and all direct costs necessitated to bring the project into fruition is extremely helpful as one measure of the economic merits of the proposed project. The establishment of any fixed figure of a ratio with a minimum below which a project would be assured of rejection and a second level above which a project would be assured of acceptance appears to place an unwarranted emphasis on the validity and accuracy of such an index. The benefit-cost ratio is after all but an estimate and can be accepted as only one measure of the national and public worth of a project.

### TOTAL COSTS

The subcommittee recommends that project proposals submitted to Congress by the executive branch include a statement of project costs. These project costs should include all the monetary and financial outlay of a program or project consisting of the investment costs, the operation and maintenance costs, tax costs (or, in a Government-owned project, payments in lieu of taxes), and interest on the unliquidated balance of the reimbursable investment costs and unamortized balance of the nonreimbursable investment costs.

Investment costs should include expenditures and payments for any contributions toward project construction, including materials, energy, and supplies; postauthorization surveys, plans, and designs; labor and supervision; lands, easements, rights-of-way, and water rights, relocations; damage claims; interest during construction; maintenance during construction; and capital replacements or additions.

Operation and maintenance costs should include postconstruction expenditures and payments for, and contribution toward, the procurement of materials, energy, supplies, labor, and supervision needed to operate a project and to make repairs and for minor replacements for keeping the project in sound operating condition.

### ANNUAL COSTS

The report of project proposal should also include a statement of costs reduced to an annual basis. Such reduction should contemplate amortization of the works within their useful life but in any event within a period not exceeding 50 years. The interest rate used for application for Federal costs, unless specifically otherwise prescribed by law, should approximate the long-term rate currently being paid by

the United States Treasury and for non-Federal costs should approximate the current rate expected to be paid by non-Federal interests on bonds for works of the type involved. The interest rates to be used should be prescribed from time to time by administrative order so that uniform measures will be used by all of the Federal agencies proposing water resource development projects.

### BENEFITS

As a third element in the economic study, the report should include an estimate of benefits directly attributable to each of the purposes for which the project is proposed to be authorized. These should be expressed as an annual monetary value and a comparison of them with costs should be expressed as a benefit-cost ratio.

The presentation should also discuss clearly and concisely both indirect or secondary and intangible costs and benefits with such estimate of their monetary value as may appear to be reasonably realistic and appropriate.

In addition to such an over-all study, there should be included a statement of allocation of costs to the particular purposes for which the project is proposed together with a comparison of pertinent allocations to estimated, reasonably obtainable receipts for vendible or reimbursable features and there should be stated a comparison of costs proposed to be borne by local interests with benefits essentially local, including increased value of both agricultural lands and nonagricultural property.

The subcommittee recommends that future proposals and reviews of proposals for projects include the foregoing described elements of economic evaluation.

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